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FINAL - REPORT

OBSERVATIONS AND RECOMMENDATIONS FOR A DISEASE PREVENTION PROGRAM FOR AMERICAN CONIFERS IN YUGOSLAVIA

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ACKNOWLEDGMENTS

I wish to express my appreciation for the opportunities and challenges presented by this assignment in Yugoslavia. At the same time the cooperation, courtesy and friendliness offered by so many administrators and foresters has been an inspiration as well as a distinct pleasure.

My sincere thanks are extended to my several guides and interpreters. I appreciate the difficult nature of their job, particularly since many operated with but short notice of my visit.

Robert W. Brandt

Introduction

An examination of the health of introduced American conifers was made during the first two months of the author's stay in Yugoslavia. This involved visiting the forest tree nurseries as well as both young and old plantings in which the American species grew. Particular emphasis was placed on the eastern white pine (Pinus strobus) and the Douglas-fir (Pseudotsugae taxifolia) since these two species are of prime importance to the Yugoslavs.

This report is based also on the impressions and ideas gained during numerous discussions and conferences most of which took place during the latter part of this four month assignment.

As developed during initial conferences with members of the Institute for Technical Assistance and Union of Chambers of Agriculture and Forestry the objectives of the program were:

1. To visit and examine plantings of eastern white pine and Douglas-fir and to give an evaluation of the state of health of these two species.

2. To give recommendations for prevention and control of the diseases affecting these species in the nurseries and plantations of Yugoslavia.

3. To assist the Conifer Institute of Jastrebarsko in organizing the program and methods for research studies on diseases and suppression of diseases of American conifers.

4. To give lectures at the various centers of higher learning based on the above three topics and to participate in a Symposium for Forest Tree Protection.

Review of American Conifers in Yugoslavia

This portion of the program has been presented as an interim report for the period October 18 through November 30, 1961, and appears as the first appendix to this final report. Since the time of completion of the above-mentioned paper further field work and discussions with various individuals and groups calls for a resume of some of the most obvious points.

In general the forest tree nurseries in Yugoslavia have many basic protection problems to solve before they are ready or able to concentrate on the niceties of production for a single tree species such as Douglas-fir or eastern white pine. The basic production problems have been thoroughly documented along with practical recommendations for their remedy in Dr. Felix Czabator's 1961 report "A Modern Forest Nursery Program for Yugoslavia". The writer is in complete agreement with Czabator's report and it seems to me the next step is for the Yugoslav authorities to get this report in the hands of its people who are responsible for nursery production and to get these same responsible people located on the nursery where they can work more effectively.

The younger plantations of Douglas-fir and eastern white pine are not nearly as healthy as their 40-year-old or older predecessors. In the case of D. fir this is directly related to the fact that needle cast fungi, presumedly introduced in small amount on young trees brought in for the early plantings, have now

increased to the point where they are seriously attacking the new plantings. Without a doubt these needle casts will be the limiting factor in growing D. fir in many areas. The white pine is endangered both from the presence of blister rust and a serious buildup of root rot fungi on reclaimed low grade forests.

While the two species are basically healthy in plantations over 40 years, mo have stagnated between the ages of 55 to 70. This should make little differenc if the rotation for harvest is at 30-35 years as planned. One rather serious flaw in looking at these older trees while extending planting plans for the future is the above-mentioned change in the disease status, particularly for D. fir. Another lies in the fact that the old plantings were small in size, widely scattered and in largely favorable soils and sites while such is not true for many of the young plantations. In addition, much of Serbia and Macedonia has little indication as to the possible success of these species.

PROTECTION OF CONIFERS IN YUGOSLAVIA

This paper will attempt to cover some of the basic considerations for the protection of conifers in the forest tree nursery and in forest plantations, with particular reference to the Douglas-fir and eastern white pine.

Parts I and II will be general enough that much of the information may be useful in the protection of some of your native coniferous species. Parts III and IV deal specifically with serious diseases presently occurring in Yugoslavia on the Douglas-fir and eastern white pine. The last part of my presentation will concentrate on some of the fundamental principles of a plant protection organization.

A copy of this paper has been prepared for your use. I will attempt to stay within the framework of your copy but may take the liberty of presenting certain added information. I welcome any questions or discussion that you may wish to present

Part I - Nurseries

The proper synchronization of all the necessary scores of individual operations in a forest tree nursery is probably the most important disease preventative measure that can be taken. Complete harmony is virtually unobtainable since conditions are continually changing. Such change makes it mandatory that a highly alert, well-trained man be almost constantly present on the nursery grounds to weigh the effects of such factors as fertilizing, insect or disease outbreaks, soil fumigation, etc. He must be given the responsibility needed to make immediate decisions for even short delays may cause subsequent heavy losses. Some of the more critical factors and their relation to tree disease are discussed in the following paragraphs.

Soil and site

The Czabator report calls attention to the heaviness and high alkalinity of many of the soils in Yugoslav conifer nurseries. Heavy clay soils result in frost heaving in the winter while in summer they may actually bake when dry or become even heavier and sticky when wet. While both white pine and Douglas-fir will grow in these soils they prefer a loam or sandy loam and cannot produce their best root system in heavy clay. It is likely that much of the problem of damping-off and root rot in Yugoslav nurseries may be directly related to the use of such soils for nurseries.

White pine and Douglas-fir prefer soils in the neighborhood of pH 4.5 to 5.5 but in some nurseries the soil acidity is known to vary between pH 6.5 and 7.0. Such high pH definitely favors damping-off and chlorosis and may be in part responsible for root rots.

Another objection to the use of such heavy soils for a nursery location is that every slight depression in the seed beds results in standing water. Depending on the depth and duration of the water a wide variety of nutritional and disease troubles may occur.

Other than soil texture a number of factors of site should be considered. Freedom from early and late frosts is necessary, particularly for Douglas-fir, since strains are highly susceptible to frost.

Exposure to drying winds, extreme direct sunlight, and prolonged flooding are all hazards to young seedlings but in different ways. The production of either of these American species on river flats where they are subject to periodic and sometimes prolonged flooding should be ceased.

Drainage

A well-drained soil should be a must for a nursery producing eastern white pine or Douglas-fir. Many nurseries visited have had areas where standing water or a high water table was a problem. Such excess water tends to leach out nutrient elements and encourages various diseases - especially root rots and damping-off. Wet seed beds, particularly those in which the seedlings are too dense, favor the growth of numerous molds and parasitic fungi which may cause top-killing in the beds or storage problems between digging and out-planting. These problems are often severe where organic matter has recently been added to moist soil.

The best preventative is to refrain from using such wet soils for these conifers. The only other practical solution would be to shape the beds above the level of the paths and provide drainage (open ditches or underground tile) at intervals throughout the nursery.

Fertilization and Soil Amendments

Fertilizers are a necessity in the forest tree nursery but one must use them in well-planned fashion lest serious disease problems arise. All adjustments of nursery soil fertility should be based on soil analyses and soil specialists should be consulted. The entire field of tree nutrition and forest tree physiology is relatively recent and new and valuable information is continually being published. In spite of the flexible nature of the subject certain beneficial relationships are apparent and are being adapted to the forest tree nurseries.

For the highly alkaline soils of most Yugoslav nurseries fertilizers such as ammonium or potassium sulfate should be used. Their acid residues will serve to reduce seedling diseases such as damping-off, chlorosis, and root rot. These fertilizers also promote the availability of phosphates, iron, manganese, calcium and boron to seedlings since these elements are often precipitated as insoluble salts in alkaline soils. Users of this type of fertilizer, and of ammonium sulfate in particular, should be cautioned against late season applications which increase susceptibility to frost and winter injury and encourage abnormalities such as forking, fasciations, etc. There is also the danger of promoting chlorosis, particularly in crowded parts of the seed bed, and any application of ammonium sulfate should be followed quickly by a moderate to heavy watering to prevent burning of foliage by the chemical.

While Czabator (p.35) gives the full particulars for increasing Yugoslav nursery production by the use of chemical fertilizers, I should like to recall to your minds some of the relationships between fertilization and tree diseases. As you know, the amount of fertilizer one adds to the soil influences the severity of diseases as well as the nourishment and vigor of the trees. Even more important than the total amount of fertilizer, however, is the proper balance of the nutrient elements. A deficiency or surplus of any one element often promotes disease. Potassium deficiencies have caused serious disease outbreaks in many forest nurseries of Europe. Small scale trials with potassium, magnesium, manganese or iron should be tried where potassium is deficient and plants show symptoms of stunting and chlorosis.

Lack of phosphorus causes conifers to be generally poor and uneven in growth and causes them to become purple in winter. Application of superphosphate in some United States nurseries has corrected this deficiency. Nitrogen excesses sharply promote damping-off and root rots.

Even when balanced fertilizers are applied and the plant is properly nourished serious problems may arise. It is well-known that many diseases are most destructive when plants are growing most vigorously. Then too, the available nutrients may soon be lost through leaching action of micro-organisms and the varying nutritional requirements of different species. It is known that fast growing species are quite different in their nutritional demands than are slow growers and it may prove to be that even fast growing individuals may differ in this respect from slow growing counterparts in the same species.

Such variation in tree nutrition, coupled with a rotating forest tree crop and the inherent differences in nursery soils and sites, make it obvious that there can be no standard fertilization program for Yugoslav forest nurseries. It is less apparent but fully as important that the individual nursery program be based on oft-repeated soil analyses, on trial plots, and close observations and statistical comparisons of these trial plots so that the most productive methods of growing healthy seedlings are being used in each nursery. Needless to say, this calls for a highly trained permanently located nurseryman and access to experts from various fields to advise him in special problems. These remarks hold true, not just for fertilization, but for the entire range of nursery activities whether spraying, soil fumigation, soil amending, acidifying, testing seedling rates, determining watering schedules, etc.

The use of organic matter or humus in Yugoslav nurseries is most valuable in improving soil structure. Recommendations for cover crops and manures has been covered by Czaudes. As in the case of fertilizers the actual timing, rates and effect of such treatments will have to be worked out at the nursery level. Soil amendments beneficial to one tree crop in one location may be extremely harmful to another or to the same crop in a different location.

While the application of organic materials add nutrients to the soil the immediate effect is to tie up the available nitrogen. The effects in regard to disease, is good or bad depending upon the particular disease and the development of the host and of the causal agent. Root rot and damping-off fungi are often stimulated by organic matter near seeds and seedlings. Animal manures should be composted for at least a year before being used in seedbeds. Plowing under of green cover crops should be completed a month or even two months prior to seeding to prevent large increases in seedling diseases.

An increasingly common practice in forest tree nurseries is to use sawdust to cover newly sown seeds. Rather than remove the sawdust after the seedlings emerge it is left to disintegrate and be incorporated into the soil. Unrotted sawdust, while not directly causing disease, does tend to promote danger from drought and heat injury particularly in nurseries lacking an irrigation system. Rotted sawdust will help acidify alkaline soil but at the same time will usually lead to nitrogen deficiency unless additional nitrogen is made available.

Forest litter or duff is undoubtedly one of the safest materials that can be used to increase the fertility and physical properties especially if composted

before use. Worthy of mention in this connection is the introduction of pine needles to formerly pine-less areas for the purpose of promoting mycorrhizae. As you may know, various deficiency diseases are often associated with the absence of mycorrhizae. The beneficial results from addition of litter to nursery soils is becoming increasingly apparent. Much successful work has been done along this line by the Canadians. Comparative studies have shown that seedlings with mycorrhizae have resulted in better survival and growth in plantations than have those without.

Soil acidification

While soil acidification was touched upon in connection with fertilization and soil amending the subject is worthy of a few more comments. Both eastern white pine and Douglas-fir grow most rapidly and maintain their best health in somewhat acid soil. Most Yugoslav nurseries are more alkaline than desired by either species. It is my conviction that much of the loss due to damping-off could be eliminated by the use of some method of soil acidification. The best method and the degree of acidity that is safe and effective will not be the same for all nurseries nor will it necessarily be the same in all parts of a nursery.

Because this is so - many chemicals have been used to reduce alkalinity in soils. Formaldehyde, acetic acid, chloropicrin, sulfuric acid, aluminum or ferrous sulfate, hydrochloric acid, and certainly others unknown to me. I see no need to go into detailed instructions on timing, amounts, or methods involved in using each. Such specific recommendations for use are given by the manufacturers of these chemicals and the nurseryman is obliged to vary these recommendations to suit his needs.

In general, formaldehyde, acetic acid and chloropicrin are applied a week or nearly two weeks before seed is sown. Sowing date depends largely upon soil temperatures after treatment since noxious gases remain longer in cold soils. Surface treatments of sulphuric acid or of aluminum or ferrous sulfate are usually made immediately after seeding. Post-emergence treatments with the sulphates may be made about a month after emergence. Hardened seedling stems will not usually be subject to damping-off at this age but the late treatment may be very effective where root rots are a problem in alkaline soil.

Since aluminum and ferrous sulphate are cheaper and much more easy to use than the other chemicals, these should be the first tried where damping-off is severe. Incidentally, eastern white pine generally doesn't need soil acidification for damping-off, but may require treatment as a preventative for root rots. Douglas-fir on the other hand is highly susceptible to damping-off.

Soil Disinfection

Production of large numbers of healthy seedlings is the ultimate goal of the forest nurseryman. Soil disinfection with chemicals is becoming a helpful method of achieving this production. Control of plant disease is the primary reason for its use but side benefits, such as weed control, insect control and growth stimulation, are becoming increasingly important.

Greatest success with soil disinfection in the United States has been in the Southeast where temperatures are relatively high and the soil is tillable throughout

the winter months. Best results have been achieved in sand or sandy loam soils while poor or unpredictable results have been obtained on heavier soils comparable to these in Yugoslavia. One thing seems certain and that is that soil disinfection should not be made a standard nursery practice. It may be very beneficial in places where seedling losses are heavy but unless the cause of loss is known soil treatment may be just a waste of time and money.

Frankly, I have little idea of how beneficial soil disinfection would be for your nursery soils. I would certainly wait until other methods of control had been tried first. Then if root rot or damping-off continued to be serious I would attempt small trials of various chemicals to develop methods, find the best chemicals and become familiar with the responses of the trees.

The most important thing to know in soil disinfection is that the chemical must be applied properly if the treatment is to be successful. A few general statements can be made that cover the use of most disinfectants. The soil must be in good condition. This means well-prepared, loose and free from lumps. It should be just moist enough for good seed germination and for most disinfectants should be at a temperature of 10-27° C. The optimum temperature varies for each chemical and the manufacturer's directions should always be consulted before use. Application equipment should be functioning properly. All areas should be treated since there is a chance that pathogenic organisms may reinvade the treated areas. Depth of application should be as uniform as possible else the organisms near the soil surface may not be killed. The most desirable depth for most materials is about 8-10 cm. A plastic, water, or soil seal is used to confine the fumigant in the soil in some cases until the proper degree of disinfection is obtained. The materials are toxic to all plants and to humans and animals so considerable care must be taken. Time must be allowed for the gases to diffuse out of the soil before seed is sown. This time allowance depends upon the chemical, the temperature following treatment, moisture, rate of application and the crop to be planted. Cover crops should be plowed and disked under and allowed to rot for at least a month before disinfection. In the south fumigation may be done in the spring - once the soil is above 10°C. In more northern areas fall treatment is necessary since spring is usually too wet and cold and the time between soil warming and planting is limited.

Soil fumigants are sold under many names but so far they all fall into four classes or groups. They are represented by methyl bromide, chloropicrin, dichloropropene and ethylene dibromide.

Methyl bromide acts in four ways. It controls disease, insects and nematodes in soil; controls weeds; and often stimulates trees to further growth. In many cases it eliminates damping-off losses and is more effective than mineral spirits for weed control. Seeding rates may be reduced as much as 40-50% with good seed. It has not been too successful with white pine. Brozone is a special formulation containing 50% by volume methyl bromide and 50% of light volatile oils such as mineral spirits. Both methyl bromide and brozone are best applied by injecting into the soil with chisel application followed by polyethylene covers.

Chloropicrin, dichloropropene and ethylene dibromide are all used to control insects and nematodes. They have little or no effect on fungi or weeds. Chloropicrin requires a water seal to promote disinfection but neither of the others

require seal or cover. Residual toxic effects of all three may last nearly two weeks in some soils.

Seed Provenance

In none of the old stands of eastern white pine and Douglas-fir and in few of the young stands is there a knowledge of the origin of the trees in Yugoslavia. Now even though several of these small plantings show great promise for their particular area there is no way to obtain further similar seed supplies. All introduced seeds should be known exactly as to location, elevation, forest type and collection date. Forest tree seed is scarce and expensive and seed imported from other countries is not always the best. Therefore it becomes increasingly important to be able to request seed from a specific area knowing fully well that it will be productive on its intended site.

In the successful plantings now in Yugoslavia the weak and poor shaped trees should be culled out so that seed is derived from the best possible parents. For a long range program it may be feasible to develop seed orchards from these superior trees. There is, however, no assurance that the present trees are necessarily the best that can be introduced to Yugoslavia. Along with the program to increase production it might well be wise to introduce new seed origins to test in various parts of the nation.

Seed Treatment

Various fungi may invade coniferous seed or young seedlings particularly when the soil is very wet and cold. To prevent such attack the seeds may be coated with a fungicidal chemical. The chemicals may be applied as suspensions, liquids or dusts. Seeds may be soaked in a thick suspension or slurry of a chemical in water. This eliminates the danger of inhaling dusts and permits more uniform dosages to be applied. A concentrated solution of some fungicides such as Panogen or Ceresan may also give good protection. Seeds rolled in the dry powders of Captan or Arasan will almost certainly yield better results than will untreated seeds.

The most effective and therefore probably the cheapest method of treating the seeds of most conifers is known as pelleting. A fungicide is rather firmly adfixed to the seed coat by means of a suitable adhesive. The fungicide then sterilizes the soil near the seed, sterilizes the soil through which the germinating seed passes and even protects the seedling after emergence by the small quantities of material which may wash from the seed coat to sterilize the stem. Most pelleting in our nurseries is done in an ordinary motor-driven cement mixer, but small quantities of seed may be pelleted on a plastic sheet. The best adhesive has been methyl cellulose at about one part to fifteen parts of water. This must be prepared several days ahead of intended use since methyl cellulose dissolves slowly in water. The amount of adhesive required depends on the size of the seed and the amount of the dust to be fixed to the seed. The seeds are thoroughly coated with adhesive and the fungicide added. Most fungicides will be needed in the proportions of one to four, that is, one kilo of dust to four kilos of seed.

Insecticides may be applied in the same manner and may be added at the same time. Compatible fungicides and insecticides such as captan-dieldrin and thiram-dieldrin are available. It is not wise to pellet with insecticides alone since they predispose seeds and seedlings to attack by soil fungi.

Attempts to apply fertilizer as a seed coating have not been too successful. Many fertilizers tried have caused the adhesive to fail and others have injured the young plants as they emerge from the seed. When a bird or rodent repellent is needed it can also be incorporated into the pellet. It should be added last just before the seed is removed from the mixing apparatus.

Regardless of the method of treatment or chemical used, direct coating of the seed may not protect the seedlings from post-emergence damping-off. It then might be necessary to follow with a spray. One of the most successful and least dangerous materials that can be used is 75% Tersan. This may be applied two or three weeks before germination and repeated at intervals after seedling emergence until danger from damping-off is past.

Covering Seed

There is a very close relationship between depth of seeding, the material used to cover the seed, and the degree of seed germination. Seeding depth in Yugoslav nurseries is consistently too great and is believed to be the direct cause of considerable pre-emergence damping-off. The depth appears to be particularly critical in some nurseries since the same heavy clay of the nursery beds often serves as the cover. Present practices in most United States nurseries is to use an acid sand or a loose cover of pine needles or sawdust. The sawdust appears most promising for Yugoslav nurseries. Old partially decayed hardwood sawdust (beech or oak) at a depth of 2-3 cms. makes a good cover and mulch for the winter. Both white pine and Douglas-fir give better germination and bigger seedlings when fall sown under sawdust. Germination may be a little slower than with straw mulch or with sand but this delayed germination may be very beneficial in areas where the soil remains wet in spring or where there is an occasional danger from frost. After seeding and spreading of sawdust the beds may be rolled to prevent the sawdust from blowing or being washed away.

A heavy cover is nearly disasterous if a material such as an alkaline sand is used. The depth of the sand not only slows germination but the increased alkalinity causes seedlings to be very susceptible to both pre and post-emergence damping-off.

Regardless of the choice of cover a broadcast sowing of seeds will usually result in a lower percentage of damped-off seedlings than a comparable number of seeds drill-sown. While most nurseries in Yugoslavia still resort to hand sowing this relationship remains true and is probably intensified since hand sowing has resulted in extremely heavy seedling densities.

Seedling densities

Perhaps the most common faulty nursery practice, from the standpoint of disease and poor grade nursery seedlings, is the practice of over seeding. In his attempt to compensate for expected seed losses the average nurseryman often creates far worse problems by establishing such heavy seedling densities. This is especially so if the losses from birds, insects, and pre-emergence damping-off

fail to develop. In the resulting dense stands the seedlings are tall and spindly, and their color and general health may be poor because of serious competition for available nutrients. Even though the total number of seedlings may be high, the number of good quality seedlings capable of surviving in the field may be drastically lowered.

In dry weather dense seedling stands are very susceptible to drought injury. Douglas-fir seems to be easily subject to chlorosis, damping-off and nutritional disturbances. White pine may occasionally be so afflicted. With excess moisture molds develop and these and other fungi may spread rapidly through the closely packed seedlings causing complete kill over large patches of the beds.

To overcome the ill effects of over-seeding some nurseries in the United States are actually experimenting with mechanical thinners, use of chemicals to kill strips of seedlings, and a flame throwing device to burn out groups of seedlings. Occasionally they will also resort to hand pulling to prevent disease loss in the crowded beds. These methods are wasteful of time, manpower and money and could be eliminated by more attention to seeding rate.

The proper density for each nursery and for each tree species is best determined by experience and consideration will have to be given the length of time seedlings are to stay in the seedbeds. With the right density seedlings will have enough growing space and yet will protect each other from heat injury, and will act as a mulch to protect each other against frost heaving and winter killing.

Shading

Eastern white pine usually does not require protection from sunlight. Since most white pine is fall-sown the seedlings are normally well-advanced before the sun is hot enough to cause heat injury. If there is some indication of damage it is better to water the seedbeds well in order to lower the surface temperature rather than set up shades.

Douglas-fir stems are readily killed by heat at the ground line if not shaded for the first few weeks after germination. The most commonly used shades are made from lath placed on a frame so that 50% shade is provided. These laths must be placed at a height (45-50 cm.) above ground so that air may flow beneath and prevent moisture accumulations which would promote molding and top damping-off. If the weather is cold and wet for a prolonged period the shades must be removed.

Watering

Many forest nursery problems are directly the result of water excess or deficiencies. In this light the seemingly simple process of watering can become one of the most important means of preventing seedling diseases. In time of dry weather young trees must be watered during, and for the few weeks following, germination. On sunny hot days seed beds may be lightly watered to cool the soil but normally it is better to water rather heavily and less frequently. Late afternoon or evening watering is to be avoided since the moist seed beds have no chance to dry before nightfall. A build-up of diseases such as damping-off or needle casts is encouraged by the moist, cool conditions which then

prevail through the night.

Besides the regular schedule needed to promote the best growth of seedlings, watering may be resorted to in order to lessen damage from frost, and as mentioned, to cool the soil in summer.

Spraying

There is little question but that fungicides have definitely "arrived" as far as the forest tree nursery is concerned. There are many types with many specific uses and the choice of one fungicide over another is governed by the disease, the crop, and to a lesser extent by the cost, availability, and ease of application. There are no general, standard spray programs such as practiced in fruit orchards or commercial landscape nurseries. The forest nurseryman must be able to recognize that he has a problem, then he must have access to specialists who can observe, study, and make recommendations for attacking that problem.

In the nursery most disturbances only become visible as foliage symptoms. Many of these will be root problems and must be treated by fertilization, soil amendments or fumigation. Others will be caused by fungi attacking the foliage directly. Once a problem is known to be fungus caused a fungicide can be applied, most often beginning in early spring as the new leaves develop and before infection occurs. Repeated applications are usually necessary at 10-14 day intervals until all danger from infection is past. One example that could be mentioned here is the use of fungicides such as ferbam, Bordeaux mixture or Orthocide for controlling Lophodermium pinastri. Any one of these materials will check Lophodermium but control usually breaks down in improper timing, lack of proper coverage, or failure to maintain coverage over the entire infection period.

In recent years considerable attention is being given to timing protection operations with the periods when infection is likely. Thus by knowing the sporulation habits of the organism and by gauging temperature and moisture relationships which favor spore formation one can practice control methods only when control is needed. Considerable saving is made in manpower, time and money.

Such a program can only be realized when the disease is thoroughly known for the area involved, when a correlation of the life cycle of the organism and weather has been made, and when a competent and highly cooperative weather predicting force is available.

Since the common methods of controlling seedling chlorosis largely involve the use of sprays it seems appropriate to include the topic here. Chlorosis, as you know, is the symptom revealed when the plant has a deficiency of green pigments. Such deficiencies are a biochemical response to various adverse conditions. In addition to yellowing, the needles may be short and curled, the terminal buds may fail or be dwarfed and the current growth is usually most affected. Some of the most common causes are low temperatures, lack of nitrates, full strong sunlight, high temperatures, nematodes, excessive water and lack of iron. There is no way to determine exactly what causes a particular chlorotic outbreak and the nurseryman is obliged to set up trials with different treatments until he succeeds in finding a cure or is forced to give up the area.

Here in your nurseries the first trials should be with ferrous sulfate or ferrous citrate sprays since the limestone origin of the soils would make it likely that the chlorosis is due to iron deficiency. Actually there may be adequate or even excessive quantities of iron but these are made unavailable by the action of calcium compounds. Addition of iron in a soluble form to roots or leaves beginning in April or May and continuing at 10 day intervals through July should eliminate chlorosis through the winter and ultimately should result in smaller losses from winter kill.

Chlorosis due to nitrogen deficiencies can be corrected by addition of ammonium nitrate but care must be taken since this fertilizer tends to leave an alkaline residue upon breakdown. Chlorosis caused by unfavorable weather conditions is sporadic and temporary and usually cannot be corrected by chemical treatment. Regardless of the cause chloratic plants should be discarded when transplanting or when field planting.

In rounding out the subject of spraying in the nursery one naturally touches on insecticides and weed-killers. Many newer insecticides remain effective in the soil for some time. Benzine Hexachloride (BHC) kills or deforms many seedlings. The cotyledons die back, stems become twisted and roots are shortened and club-like. While other compounds such as chlordane, aldrin, or dieldrin have not produced these abnormalities it is still not known what their cumulative effects may be. Results have varied with the soil type and plant variety. Any control for insects using these materials should be made on small plots followed by seeding in order to test for possible plant injury.

Weed killers are becoming of increasing importance to the nursery. Mineral spirits are mixtures of aromatic hydrocarbons made from petroleum. Their ability to kill weeds seems to be approximately proportional to the aromatic content. In total they are the most widely used herbicides for weed control in conifer nurseries. They are most effective on very young weeds and it has been found that frequent and light applications during the active growing season kill the most weeds and do the least harm to conifers. Even then caution must be exercised lest seedlings are killed or seriously injured. Conditions for application must be near optimum, the soil moisture must be high and it is necessary to water before spraying. The seedlings themselves must be allowed to dry before the herbicide is applied in order to prevent burning. Emerging seedlings should not be sprayed with dosages heavier than 55-75 liters/hectare. This can be increased to 140-180 liters/hectare after three or four weeks. Spraying one to two times per week will kill the weeds as they emerge. The seedlings must be in good vigor for weak, chloratic seedlings are often killed before the weeds. The oil must be applied by means of a power sprayer traveling at an even rate. Hand applicators are too sporadic and with them material is lost, areas are skipped or overlapped, and the area that can be covered is small. White pine and Douglas-fir can both tolerate the use of mineral spirits but it should be noted that larch and broadleaf trees cannot.

Simazine and Eptan are even more hazardous to use. Again lower dosages applied more frequently are preferred. Rarely would it be wise to use over 5 kg. per hectare for pines. These herbicides should be used in small trials before large scale treatment of weeds in Douglas-fir is made.

Part II - Plantations

The first and most important factor in any afforestation or reforestation program is the production of high quality nursery stock. On the other hand there is no need to go to all the trouble and expense of producing these quality trees if they are not to be given the benefits of proper site and care in the field. Trees on off-sites and without attention are quickly subjected to many troubles. The wide spectrum of troubles that fall under the heading of tree diseases are a constant threat throughout the life of a tree. The majority of tree diseases should be prevented rather than controlled and they may often be prevented by a careful consideration of some of the basic techniques of silviculture.

Site and Site Preparation

Without doubt the underlying cause of plantation failure in many parts of the world is the lack of proper site for the species involved. There are many reasons for this and most of them are deeply ingrained in lack of knowledge - or worse, a lack of proper respect for the knowledge that we do have. We need to know the area we are to plant. We should know the soil - its depth, acidity, permeability and fertility. We should know the over-all topographic and climatic features of the site - its temperature extremes, precipitation, possible subjection to floods and erosion, and the effect of its exposure on the species we choose. We should know the trees - their nutrition, tolerance, vigor and resistance to the various organisms and conditions to which they would be subjected. Then we should carefully select the tree and test it by limited plantings and if proven successful we should cautiously expand its use to similar areas. In too many instances our forestry people are planting the species that the nursery has available - not the species we ordered. Or we may plant an area to a species that is in great demand although we may know of a species that would better fit the site.

Almost by definition, stands on good sites are the most vigorous. In most instances the important factor in resistance to disease is tree vigor. Stands on poor sites are heavily attacked by a host of disease producing organisms. Often an attack by a pathogen may be useful as an indicator of poor site for a particular species. The fungus Diplodia pinea unfailingly attacks Pinus nigra on poor sites in the northeastern United States. Armillaria mellea and Trametes radiciperda serve the same purpose for many conifers although these may also occur as a direct response to drought even on good sites. The greatest amount of care either in site preparation or in later silvicultural manipulations cannot hope to make a stand completely successful on a poor site. Conversely, a fair or good site may cause the native hardwoods to over-grow the conifer plantings and make the conversion too costly and unpredictable.

Some preparation of the site is necessary in most cases of reforestation and particularly so when converting low-grade hardwoods to conifers. The use of bull-dozers and root rakes is the most common method but chemicals such as 2, 4, 5-T, ammate, or sodium arsenite are being used. These chemicals have not been overly successful in pre-planting operations but are quite widely used in releasing conifers. Care must be used in selecting dosages and in application since serious burning of the foliage of conifers has resulted. Most of these

materials are still in what might be called the "advanced research" stage and so any use here would have to be done initially as trials to obtain information for further work.

Size of Planting

The suggestions made here on the size of the plantings that should be made are purely opinion and I can offer no data to back them up. I recommend against any large scale planting of Douglas-fir for I feel strongly that the Douglas-fir will not be a successful introduction to Yugoslavia. The healthy appearance of some of the old stands scattered through Slovenia and Croatia are not truly indicative of the welfare of the present young stands. A few small, scattered test plantings would be in order for Serbia and in some of the mountain areas of the south. The reasons for the failure of Douglas-fir will be discussed shortly.

The areas of eastern white pine are becoming increasingly larger in size through the rather prolific natural regeneration from existing stands and through planting brought on by pressure to increase coniferous acreages. The need for the increase is well recognized as is the possible role of white pine in filling this need. A few words of caution on the relation of plantation size and disease outbreaks are in order.

Large areas of pure stands of any species not normally growing alone have been notorious for their rapid deterioration due to both insects and disease. Many of your younger white pine stands are beginning to show root diseases, insect build-ups and, while not of critical importance at the present time, the white pine blister rust is present in Yugoslavia. In addition to the known hazards so much of your white pine must be in areas where lack of previous plantings of the species makes the possible dangers totally unknown. Therefore, I suggest that white pine plantings be limited in size - say in the neighborhood of 2-4 hectares and these to be established at rather scattered locations until further knowledge is gained of where the tree might be successful and where it will also be an extremely costly failure.

Plant Material

As long as one is involved in the expense of artificially reforesting an area it seems only logical to state that one should obtain seed and hence seedlings from the best possible strains. The seedlings produced should also be as free from pests and as healthy as possible to increase the individual's chance of field survival.

Seedling size has much to do with survival. Both Douglas-fir and eastern white pine are being planted as 3-0 or 2-2 stock in the United States. The use of 5 and 6 year old stock is difficult to justify. These larger trees are considerably weakened by the shock of being moved bare-root to a new location. It is much more difficult to properly position the roots of larger trees and undoubtedly predisposes the tree to infection by Armillaria mellea or trametes radiciperda. These larger trees are particularly susceptible if they have been forced to any degree by excessive watering or fertilizing. The high cost of

transplanting such trees seems rather wasteful as does the practice of keeping them in the nursery when new crops of seedlings could be grown in the space.

Species Mixtures

Just as there is a tendency to increase the size of plantings so is there another tendency to establish pure plantations. There often is little or no regard for the conditions under which the tree grows in its native habitat. Thus, white pine reaches its best development in mixture with hardwoods while Douglas-fir grows naturally in association with other western conifers. The latter is currently found in large pure stands in western United States only through the destructive effects of fire, insects and diseases, and more recently through clear-cutting. Many of our pure stands, and especially those in plantations are even-aged and any parasite which is particularly virulent at a given age may wipe out the entire stand.

The practice of planting white pine beneath a light hardwood over-story is a good one and should be continued. In some cases the remaining hardwoods are being cut out after which a rather heavy buildup of root-rot fungi develops. Douglas-fir is somewhat tolerant in early years and may be planted beneath light shade. In a very short period (6-10 years) it should be released from all top shade and from most side shade if growth is not to be restricted.

Agricultural - Forestry

It is far too early to determine the success of the practice of inter-cropping between rows of coniferous trees. Foresters throughout the world are awaiting the results of such tests and you people are to be commended on your explorative efforts. Once again, the expense of the operation, particularly where using such large planting stock, seems a bit prohibitive. This cost will undoubtedly become greater as the exodus from farm and village to the city continues.

From the forestry and forest pathological standpoint one of the first considerations must be the tree and the encroachment of the agricultural crops on tree roots. From certain crops there may be severe competition for nutrient elements or root exudates and organic debris may be detrimental to the welfare of the tree. It is well known in forest nursery work that seedlings following agricultural crops such as corn or soybeans are particularly susceptible to nematodes and fungus diseases of the roots. Just what effect such crops might have on older trees at wide spacings is yet unknown. Another hazard to the roots as well as to the stem of the trees is that derived from the operation of mechanized equipment between the rows. Tilling the soil with a disc harrow or a plow (especially a deep-plow) can do considerable damage to tree roots.

The response of forest trees to fertilizers and cultivation is still somewhat of an unknown. Whether the benefits will be great enough to make up for the technical difficulties and for the removal of such land from pure agricultural crops remains to be seen. Another question that comes to mind is that of the productiveness of certain abandoned farm land and obviously submarginal land that is being developed for agricultural techniques. The

problem is two-pronged in that the productiveness of these areas for conifer production is fully as much a question as is its productiveness for the agricultural crops.

Stand Density

One thing that the combining of forestry and agriculture crops does definitely do is that it solves the matter of overcrowding in the stand. This almost perpetual problem which leads to stagnation and disease outbreaks should be solved completely if the technique is a success. This does not mean to infer that the disease problem will be solved, but with these wide spacings the danger from pathogens should be less. I cannot say what it might do for insects.

It is known that wide spacings increase the height as well as the diameter in Douglas-fir and eastern white pine. The need for pruning will become much greater and will come at a much earlier age than at closer spacings. The early pruning will be beneficial from a disease standpoint as well as a silvicultural one if the pruning is kept within moderation (no more than 1/3 of live crown removed) and if the limbs are saw pruned flush with the stem.

In stands where crowding is a factor diseases may actually serve as a thinning agent although no control of the manner in which thinning is accomplished can be exercised. Douglas-fir is particularly susceptible to diseases which tend to reduce the number of stems when they are too crowded. Armillaria mellea is one of the first agents to begin this elimination and may kill single trees or take them out in large groups.

Many of the pines are heavily afflicted by rootrots such as A. mellea and Trametes radiciperda shortly after over-dense stands are thinned. The latter fungus kills trees outright or permits them to be windblown by gradual rotting of the roots.

Stand density is also an important factor in snow, wind and ice damage. Both species suffer from top breakage from snow and ice accumulations. Douglas-fir in thick clumps where the trees are extremely spindly is very susceptible to wind throw following thinning. Wider initial spacing and earlier thinning should improve the resistance to these types of decay.

Sanitation

Sanitation, as usually applied to the forest, means the removal of diseased and dead trees. It may also mean the cutting of the less-desirable species or of inferior trees of a given species. In a way the more positive approach of providing a suitable mixture of species and of tree ages can be thought of as sanitation since it also tends toward making the stand more healthy.

Douglas-fir and eastern white pine are both well adapted to the use of sanitation measures since their particular diseases are aided, in part, by such treatments. The removal of branches with blister rust cankers and of trees with stem cankers is helpful in holding down the incidence of blister rust in white pine plantations although it is certainly more beneficial to eliminate the nearby Ribes.

There is some degree of protection afforded to Douglas-fir attacked by the needle cast fungi by pruning the trees so that air movements may dry the soil. Since the lower branches are commonly the most heavily infected such a procedure also reduces the inoculum potential very much.

Thinning and Pruning

There seems to be a rather basic philosophy extant among foresters in regard to plantations and that is "If it grows well - leave it alone". This probably serves well in most cases. A forest planting will usually give some kind of warning if it is not growing well, but the difficulty seems to lie in getting a critical observer back into the plantation often enough to see the changes in the stand and to note the warning signals. Such things as shortened or discolored foliage, dieback of tips, drying of the bark, and shortening of the internodes - all indicate that conditions are not as they should be. Vigorous early growth may lull the forester into a sense of well-being in regard to the stand's health, but in actual practice such early vigor is no assurance that the stand will continue to grow so well. Approaching the age of 15-20 years, or even sooner in some localities and with some species, the trees begin to make greater demands on their sites and then it is that many supposedly good sites begin to reveal their deficiencies.

Timely thinning is perhaps the one most valuable disease protective treatment that can be given to a stand and the emphasis must be placed on the "timely". It has been estimated that 75% of all England's forestry troubles from fungi and insects originate from neglect of thinning. This figure is probably applicable to much of the eastern United States as well. It is believed that many of the plantations that are thinned at the proper time are "under thinned" and the trees are little stimulated by the action. The increase in diameter is not dependent on the trees left in the stand but on the number, position and size of those removed.

The proper degree of thinning for disease prevention is usually quite in line with that required for good silvicultural practices. It is better to give light and frequent thinnings to Douglas-fir and white pine if at all possible. Dominants will respond better if their growth is continuous and continuously released trees will keep their fastest growth on the lower stem where it is most available and usually of highest quality.

The aim in pruning is usually removal of the lower third of the live crown. More severe pruning results in a sharp drop in tree vigor and easily leads to attack by root-rot fungi. Sun-scald may be a problem in either of these species if too severely pruned and epicormic branches may develop which negate much of the benefit derived from pruning. Pruning of large old trees with heavy limbs leads to decay but at a younger age there is little danger from such diseases. Removal of branches with blister rust cankers will often prevent the fungus from reaching and girdling the white pine main stems. Timing of pruning may be an important factor in disease control. For instance the canker-causing fungus Phomopsis pseudotsugae on Douglas-fir may be spread from tree to tree by pruning in the season when the tree is dormant yet if the diseased branches are removed during the actively growing period the trees are able to prevent infection.

Protection

In spite of the great advances made in agriculture and horticulture in the use of chemicals for protection against insects and diseases, silviculture and the biological manipulation of the forest environ still remain as the cheapest, most usable, and most successful methods of protecting the forest.

No safe and effective repellents have yet been devised to protect forest trees from wildlife. The obvious preference of the Yugoslav deer and rabbits for introduced conifers will continue to be a great reforestation problem and the only likely control seems to lie in controlling the numbers of the animals themselves.

The use of chemical fungicides against tree diseases is largely limited to the forest nursery by the high cost of the materials and the difficulties in getting adequate coverage on forest trees. The fact that repeated applications are necessary for effective disease protection and/or control only adds to the problem. Trials have been made against forest diseases using airplanes, helicopters, power ground sprayers and mist blowers, and various kinds of hand equipment. The trials are invariably not practical for the forest.

Certainly protection from environmental factors such as ice, snow and wind is only afforded through the development of a proper forest structure. The growing of mixtures and uneven ages as well as the wise and timely use of thinning can greatly reduce the direct damage from such conditions. Indirectly it will also reduce the number of fungus diseases that invade the broken branches and severed roots which result from such storms.

It is my contention that as long as it is possible to maintain a healthy stand of trees by the use of biological control of insect and disease problems it should be done. While there are no clear-cut examples of the biological imbalance initiated by chemical control of disease producing organisms the field of entomology is rife with such examples and man now finds himself engaged in an ever-increasing battle against insect outbreaks that result from the correction of the previous outbreak.

Part III - Douglas-fir Diseases

Adelopus Needle Cast

This disease, caused by the fungus Adelopus (Phaeocryptopus) gaumanni, is known to occur only on the Douglas-fir. It is present in Yugoslavia in the Republics of Slovenia and Croatia in young and old plantations. The fungus is a native of the Pacific Northwest throughout the same range as that of the Douglas-fir in North America. Until recently in its home range it has caused little damage, but wherever the Douglas-fir has been planted as an exotic - in the northeastern United States, in England, throughout Europe, and here in Yugoslavia - the fungus has become a serious pathogen. The destructiveness of the disease lies in the loss of or greatly impaired efficiency of the needles. The ultimate effect is a serious falling-off in growth, death of the tree, or increased susceptibility to attack by secondary organisms.

The disease is the limiting factor in the production of Douglas-fir in most of Europe and is obviously the most serious disease of its host in Yugoslavia. The disease is essentially one of importance to younger age classes and in the United States it has been found on Douglas-fir in the nursery. Thus it can be spread widely in a relatively short time and then may take years to build up in the plantation.

Diseased trees may appear perfectly green or extremely yellow in color. Heavily infected needles are cast and at times the trees may retain only the current and year-old needles. Normal needle retention of Douglas-fir in Europe varies from 5 to 7 years. Afflicted trees are recognized primarily by this scarcity of foliage but individual infected needles with the highly characteristic, extremely minute, black, spherical fruiting bodies of the fungus are needed to positively identify the disease. These fruiting bodies, or perithecia, protrude through the stomates and so are aligned along the length of the needle on the under surface.

While the fungus is found only on Douglas-fir in nature it is not an obligate parasite as it has been grown on artificial media in the laboratory. On the tree it grows only on the needles and does not penetrate into the petioles, twigs or branches. Infected needles may or may not loose their color or shape and it is not exactly known what causes the needles to fall prematurely.

Adelopus infects the newly emerging needles just as the buds are bursting. It is not known how infection takes place, but it is quite safe to assume that after spore germination occurs on the surface the young fungus plant either penetrates the surface tissues directly or enters through the stomates. The fungus then grows throughout the needle for the first few months following infection without visible signs that infection has occurred. In mid or late fall the first fruiting structures are produced. Throughout the winter months more of the fruits appear, one to a stomate, and all continue to blacken and to grow in size. In the spring as the buds develop the fungus fruiting bodies (and their spores) mature. With the arrival of favorable weather conditions the spores are released and the cycle is started over again. The needles which have produced the spores are at this time one year old. They remain on the tree and continue to produce more fruits of the fungus throughout the following year and these mature and shed spores in the second spring. This process may be repeated as long as the needles are held. This may vary from 2 to 3 years. Even though some needles are retained nearly as long as are uninfected needles the diseased needles are largely non-functional after the first or second year due to the improper operation of the stomata and resultant disruption of the photosynthetic processes.

The mature spores are released from the fruiting bodies via a small pore in the top and are carried by wind and/or rain to infect the new crop of needles. Long periods of cool, moist weather favor the disease since the spores retain their viability for longer periods and conditions are more favorable for germination. Needles of lower limbs where little air flow occurs are most heavily infected, and as the tree gets above 3-4 meters tall the foliage above this height will be increasingly free from Adelopus attack.

There is no practical control. Good results have been reported in young plantings using Bordeaux mixture (4-4-50) but this control is based on

maintaining a complete coverage of the material on the surface of the needles for several months. The time, manpower and material to do this makes it an impossible forestry practice. It was thought at one time that the green or "viridis" variety of Douglas-fir was highly resistant to Adelopus but subsequent trials have disproved this theory.

There are, throughout the planted and natural range of Douglas-fir, what appear to be individual resistances to the fungus. Such trees are being selected, propagated and tested but the program is a very long range one. Until such clones are developed or until hybrids carrying resistance to this disease are bred the future for Douglas-fir in many locales (Yugoslavia included) appears pretty dim.

For young trees already infected pruning a distance above ground level should allow the circulation of air beneath the trees and by reducing relative humidity should reduce the seriousness of the disease. It is highly doubtful if such a program would ever control the fungus.

Rhabdocline Needle Cast

Rhabdocline pseudotsugae is second only to Adelopus in its over-all destructive effects on the Douglas-fir. Again this species of tree is the only known host and while there is great racial differences in susceptibility to the fungus, all races have proved susceptible. Individual trees appear to be resistant and offer a possible hope for future control through the methods of plant breeding.

As with Adelopus, the Rhabdocline is native to the western United States where Douglas-fir grows and has only become a serious disease on exotics. Very recently in the heavily cut-over areas of Montana and Idaho the fungus is causing serious losses in young reproduction. Rhabdocline has been found in the forest tree nurseries of the New England states. It has long been known as a disease of young trees and can be quite severe until they reach about 30-35 years of age. Rhabdocline has been very damaging in Europe and losses from it have only recently been over-topped by those from Adelopus.

Infection of needles occurs in early spring as the buds burst but the disease may not be seen for several months. The first visible evidences are the minute yellow spots which appear on either surface of the needle in the fall or early winter. By mid winter the spots have enlarged considerably and may coalesce to form large brown necrotic areas or bands along the needle. In early spring a cushion or pustule-like fruiting struction develops along the necrotic bands. Maturation of the fruits and their spores is synchronized with the opening of the tree buds to facilitate new infection. The majority of the year-old infected needles are shed during the early summer months following spore discharge. Thus after a very few years the only highly functional needles are those of the current year and growth of the tree practically stops. Loss of Rhabdocline needles has been ascribed to the loss of water through the dead tissues. This sets off a chain of physiological changes which leads to formation of an abscission layer and premature shedding of needles. As with Adelopus the disease is favored by high relative humidities

and cooler temperatures. Infection from tree to tree is quite rapid. Spores are carried by wind and moist air currents and so the spread of the disease is usually in the direction of the prevailing wind.

Control is possible in some instances with use of fungicides such as Bordeaux mixture, Perbam, or Lime-sulfur. The results have been erratic, however, and again control demands that the needles be protected by the chemical throughout the period of possible infection. Such coverage is impractical for the forest. The use of antibiotic materials with their systemic and eradication features are still in the research stage and it is not known how effective they may be.

Serious outbreaks can be lessened somewhat by pruning of branches near the ground as was suggested for Adelopus. The most promising method of control is the selection of resistant trees with a program of propagation and breeding.

Phomopsis Canker

A third disease of the Douglas-fir in Yugoslavia is that known as Phomopsis canker. The causal agent is a fungus, Phomopsis pseudotsugae, which seems to be closely associated with frost injury to the bark. It is active in the northeastern United States and in Europe. It causes loss through reduction of quality of the wood when the logs are used for lumber, but perhaps of more importance to Yugoslavia will be the killing of young trees in the plantation.

Large tattered scars occur on the bole of the diseased trees. In young trees the fungus may girdle the branch or stem before the ragged affect is apparent. The fungus fruits are embedded among the loosened bark and the spores are dispersed to infect new susceptible hosts. Not too much is known of the disease nor of the fungus itself. It is an even more serious problem of Japanese larch (Larix leptolepis) in Europe than it is on the Douglas-fir.

While Phomopsis is usually found on bark killed by frost it is also pathogenic and can be easily spread by pruning while the trees are dormant. The best preventative is to prune only during the period when the trees are actively growing - thus in May, June, and July - in the areas where the disease is a problem. There is no control known for the disease on young planted stock.

Root Rots

The root-rot fungi Armillaria mellea, Polyporus schweinitzii, and Trametes radiciperda are present and active on Douglas-fir in Yugoslavia. Since these fungi are so much more serious on the eastern white pine in this country and since their effect on both trees is essentially the same they will be discussed only in connection with white pine.

Part IV - Eastern White Pine Diseases

White Pine Blister Rust

The white pine blister rust is caused by the fungus Cronartium ribicola. The fungus infects nearly all the 5-needle pines of the world but not necessarily in their native habitat. The eastern white pine Pinus strobus is one of the most susceptible of all the 5-needle pines planted in Europe. The disease has been found in Slovenia and while the infected trees were eradicated shortly after their discovery it is not known if others remain in the forest.

Without a doubt the blister rust is the most serious disease that threatens white pine in Yugoslavia. The fungus kills all sizes of pine and in general the small trees are killed more rapidly than large ones. In order to perpetuate itself, however, the fungus must spend part of its life on an alternate host, some member of the genus Ribes. These are the currants or gooseberries. In Europe the white pine has nearly been given up as a failure because of the disease but in some areas where Ribes is not present in great numbers the tree is being grown with only limited infections. Under such conditions it is being grown under a very real potential threat.

The disease on pine is best identified as a canker or lesion on the bark of infected branches or main stems. Small pines, attacked by C. ribicola, are often stunted and bushy. These trees may have short, yellowed needles and an unhealthy appearance. The white blisters containing orange-colored spores make the disease rather conspicuous during the spring while they exist, especially on young smooth-barked trees. Trunk cankers on older trees may be several feet long but may lack the blisters. Such cankers are often sunken, rough-barked and covered with resin. Branches infected by blister rust usually retain their needles as red-brown flags which serve to indicate where cankers are present. Under favorable conditions of moisture and temperature numerous branch cankers may kill a tree even when girdling stem cankers are not present. The death of lightly infected trees may also be hastened by the attack of secondary organisms such as insects, rodents, and other fungi.

On Ribes the presence of greenish-yellow spots on the under side of the leaves shows that the plant is infected. These spots develop into orange spore pustules. Later in the same areas short brown hair-like structures are produced. These give rise to more spores. The presence of these spore stages and the over-all yellowed color and sparsity of the foliage indicate that the plant has the blister rust disease.

Cronartium ribicola cannot grow in the bark of the tree once the tree is dead. Neither can the fungus travel from tree to tree but it must live a part of its life on Ribes. Since control of the fungus is based on disrupting this alternation of the fungus between the two host plants it seems apropriate to spend time reviewing the life history of the fungus and the disease caused by it.

Infection of pine takes place through the needles. After a year and a half the fungus may have grown to the base of the needle bundle and a small yellow-orange lesion or spot produced at the base of the twig. This lesion

enlarges as the fungus advances and the diseased bark becomes swollen, giving the canker a spindle-shaped appearance. In mid-summer of the third season after infection the fungus forms the first of its five spore stages. This stage has no direct effect in the disease-host picture but indirectly gives rise to the second spores which mature the following spring (May). This, the aecial stage, is the one wherein the white blister-like fruiting structures produce the orange-colored aecio-spores which may be carried by air currents some hundre of kilometers to attack Ribes.

The aeciospores infect the young half-expanded leaves of susceptible Ribes. Minute yellow spots develop on the under side of the leaves and these soon form the third spores. These infect and reinfect Ribes plants throughout the early summer until a huge potential source of inoculum is built up. At times the blister rust infection on Ribes may become so severe that the bushes become defoliated. In late summer the teliospores are produced in long hair-like columns in the same areas in which the earlier spores were formed. Under the proper conditions of moisture and temperature the teliospores germinate to produce the fifth and last spore - the one which infects the pine needles to complete the cycle. These pine-infecting spores are very delicate and short-lived so that their capacity to infect is limited to pine within rather short distances of the Ribes. Fortunately this makes it possible to control the rust by destroying all Ribes within the vicinity of white pine.

Blister rust is a rare example of a highly infectious parasitic disease that is subject to complete control. This is usually accomplished, as mentioned by destroying the wild and cultivated Ribes within infecting distance of the pines. This distance should be in the neighborhood of two kilometers near plantations and increased to three near forest tree nurseries. A program of education as to the appearance of local susceptible species of Ribes can be developed and/or pamphlets published giving their recognition features. Foreste and private owners with white pine could and should then destroy the Ribes on their own lands even though the disease might not yet be present in their locality.

There are at least five species of Ribes growing wild in the forests of Yugoslavia. These are Ribes grossularia, R. vulgare, R. aureum, R. alpinum and R. petraeum. In addition, the European black currant (R. nigrum), the most susceptible of all Ribes, has already been introduced into the country and some of these may have to be eradicated where pines are to be grown. Studies of these species, their growth habits, preferred sites, range, and susceptibili to the white pine blister rust will have to be made before a sensible program of control can be worked out. Reconnaissance surveys and experimental control programs should be completed to learn if and where control programs are necessa More test plots of white pine plantings are needed throughout Yugoslavia before the proper decisions can be made.

There are several methods of eradicating Ribes to assure control. Systemat scouting and uprooting by a crew of men is the oldest method and is also the most effective and efficient under certain conditions. Each trip across the are being worked is marked so that complete coverage is obtained. Bushes are pulle or dug out and either burned or placed where they cannot re-sprout in mineral soil. Removal of large bushes protects the area for only about five years since

many small bushes may be missed, seed may germinate, and sprouts may arise from pieces of root left in the soil.

In areas where dense concentrations of Ribes occur it may be more economical to use bulldozers equipped with heavy rake-like teeth. These teeth are run below the surface of the soil at a depth of 15-18 cms. to uproot the brush. Such a method often stirs up dormant Ribes seed which finds the large expanses of mineral soil very favorable for growth. Logging, use of heavy machines, or fire may also favor Ribes.

These methods of hand pulling and digging, and even the use of bulldozers, are difficult and expensive. The more common method of Ribes control in the United States at present is that of herbicides. Since about the mid-1940's either 2,4-D (2,4-dichloro-phenoxyacetic acid) or 2,4,5-T (2,4,5-trichloro-phenoxyproprionic acid) as either the acids or esters of the phenoxy herbicides, are used almost to the exclusion of all others. Any of our American species of Ribes can be controlled by these chemicals if the dosage, concentration, and method of application are proper. These materials are quite safe to men, animals and fish and they are non-corrosive to equipment. They are effective in quite low concentration, are non-toxic in the soil and except for occasional damage to seedlings are not harmful to conifers.

Even if it is decided to use chemical control of Ribes the problem is not automatically solved. There are many factors affecting the choice of 2,4-D, 2,4,5-T, or a mixture of these. The 2,4-D is usually about half as expensive as 2,4,5-T but may not kill certain species of Ribes. Effective control also varies with the age and vigor of the bushes and the time of year control is attempted. Thus one may have to vary the concentration of the herbicides, use various mixtures of the two, change the method of treatment or timing of the program.

Foliage sprays are the most effective and a rather heavy mist is the best type of spray. Use of a colored marker, the most effective of which has been a white water-dispersed titanium dioxide pigment, will permit an evaluation of the treated areas as to resistant foliage, adequate or inadequate treatment, or missed plants or parts of plants. If treatment cannot be made during the period when foliage is susceptible, either 2,4-D or 2,4,5-T as oil-ester solutions applied to the crown of the plant have been found to be about 95% effective against most species. In extremely rough terrain plants may be decapitated and the fresh-cut stems painted with the chemical. Thus the only equipment needed would be an axe or machete and a pocket-sized dispensing bottle of the chemical.

Other than eradication of the Ribes as alternative host, the other possible methods of control of the disease itself are relatively untried. Antibiotic treatment of pine cankers, while apparently rather successful for western white pine (Pinus monticola) in either eradication of cankers or protection from fungus infection, has been nearly a complete failure to date on eastern white pine. The reasons for the difference are obscure. It may lie in the oil carriers since the western oils were used in the west quite successfully whereas the antibiotics crystallized out of the eastern oils used on eastern white pine and and much of the antibiotic has been left on the surface. Trials are now being run in both regions using both oils. There may be some basic structural or

physiological differences in the bark of the two species that restricts penetration in P. strobus. Apparently the materials are transported systemically through both trees since basal spraying has resulted in the location of the chemicals in the needles of the upper crown.

The search for and development of rust resistant white pines is still in the researcher's hands after 25 years of investigation. Although the present results are encouraging there will be a considerable time lapse before resistant pines are ready for release. The work has progressed nicely through a cooperative approach, both on the national and international level, with a free exchange of ideas, methods and plant materials between the workers in the field. Seemingly resistant trees have been selected from areas of heavy natural infection and from plots tested through artificial inoculation. These trees have been vegetatively propagated, have been crossed with other species, and the progeny of many of the original selections and of the hybrids have been tested for resistance. This program is continuing and the most likely trees are being propagated for seed orchards and for reforestation. Of particular interest to you, will be the fact that crosses are being made between eastern white pine and your own Pinus peuce; also between western white pine and P. peuce. There are no indications yet of the success of these crosses. We do know that P. peuce is susceptible to blister rust but certainly only to a very limited extent.

The most recent method of control for blister rust involves the use of some of the oldest principals upon which plant protection is founded. The method is known as climatic escape and it is based on the proper selection of site and the treatment of the stand so that C. ribicola will not be able to infect white pine. The newness of the method is derived from its foundation on precise knowledge of the weather, of the requirements of the fungus, and of the effects of weather on the development of the fungus. In essence, white pines are located where the weather is such that the blister rust hazard is very low and, the plantations are pruned, thinned and harvested with an eye to keeping the humidity low enough to prevent infection.

Armillaria Root Rot

The root rotting fungus Armillaria mellea is generally present throughout the forested areas of the world. The spectrum of species attacked by this fungus is great and includes all the more important broadleaf and coniferous trees of the northern hemisphere. Here in Yugoslavia it has long been important in broadleaf forests and now is becoming a serious problem in young coniferous plantations. The fungus has the reputation of being an "indicator" fungus, that is, it supposedly indicates a weakened condition of a tree from some previous cause such as drought, excess water, improper nutrition, etc. In more recent infection tests it appears that A. mellea can act as a primary pathogen and therefore it becomes an even greater threat to the white pine and Douglas-fir plantations here in Yugoslavia.

Trees infected with A. mellea become stunted and the foliage is abnormally short, sparse and yellowed. The most reliable symptoms for identification of the disease are the presence of white fungus mats or felts about the root crown, and the fused masses of sand, resin and fungus threads about the crown or along lateral roots. The fruiting structure is the well-known honey mushroom which

is known by almost all foresters, the black cord-like rhizomorphs or "shoe-strings" are also used to positively identify the fungus.

Infection seems to occur most commonly at the root crown. The rhizomorphs may grow from infected roots or wood debris out through the soil until contact is made with the new host or, the growing roots of the healthy tree may come in contact with Armillaria-infected wood. If infection occurs in the lateral roots the tree may survive for years but will grow steadily weaker. When a tap root becomes diseased the fungus rapidly grows through the crown and girdles the tree. Young trees may be killed outright within the first year after infection. Trees may be killed singly or in small groups. Occasionally Armillaria-infested trees will also be attacked by Trametes radiciperda and both participate in the final kill.

It has been mentioned that the fungus is a primary pathogen - that is, it can attack a normal healthy tree and proceed to cause root rot and ultimate death. In the great majority of cases however infection occurs on trees which are low in vigor and whose natural resistance to the fungus is low. The primary cause would then be the poor site, drought, insect defoliation, etc., that caused the reduction in growth rate. Central Europe has suffered heavily from droughts of various intensities for a number of years and the great preponderance of A. mellea in the forest is undoubtedly a direct result.

Control is an extremely difficult matter. The fungus itself is universally found in forested areas. Where low-grade broad leaves are being cleared for conversion to conifers, the root debris from the hardwoods is choice inoculum for conifer root infections. No amount of site preparation such as deep plowing, bulldozing, or raking with rootrakes will remove all of this material from the soil. The fungus remains viable in the root segments for a surprisingly long time. For instance, lands cleared for citrus production and left fallow or planted to agricultural crops have retained effective Armillaria inoculum for periods as long as 10-12 years. The citrus were infected when planted in these areas at the end of that time.

It is believed that a mixture of residual broadleaves along with the conifers should help lessen the effect of the disease on the conifers. Perhaps the greatest opportunity lies in the wise choice of sites so that the conifers can maintain their vigor through the complete rotation. Since it is planned to harvest the white pine at the age of 30-35 years this may be possible.

Mention should be made of the method involving soil treatment using carbon disulfide. This chemical has been used in conjunction with land clearing for citrus groves. The carbon disulfide promotes growth of a fungus - Trichoderma viride - which has a definite antagonistic effect on Armillaria and tends to hold it in check. The method is involved and expensive and it is doubtful if it could be used in forestry except possibly for establishing new nurseries.

Trametes Root Rot

Trametes radiciperda (Fomes annosus) causes a root and butt rot of coniferous trees. It has been reported on almost all conifers as well as on some broad-leaf species. It is becoming increasingly important in coniferous plantations

in many parts of the world. T. radiciperda has been found in northwestern Yugoslavia on both Douglas-fir and eastern white pine and could become very important as more and more plantations are established. The fungus has caused decay some 2-3 meters above ground in some of the older (50-60 year old) white pine in Slovenia. Since the present plan is to harvest the trees after 30-35 years, the greatest losses will result from the killing of young trees.

It is more difficult to diagnose a case of Trametes infection than that by Armillaria. The infected tree may show no visible sign above ground and it is only when such a tree is blown over or broken over by heavy snow or ice that the root rot becomes visible. At other times a single tree or a group of trees may be completely dead at the top yet inspection of the roots reveals little decay. The most accurate identification is made when the fungus fruiting body is present. This may be at the base of the tree just above the ground level but is more often located beneath the duff.

The fruiting structure is a leathery, shelf-like or resupinate structure varying in size from the smallest button-like pustule to some 20-30 cms. in diameter. The upper surface is brown to black while the lower is pure white with minute pores lining all but the margins. The spores are released through the pores but just how much infection results from these spores is not known. Certainly they must be responsible for the long distance spread of the disease. Local spread is usually by means of root grafts and root contacts.

Infected roots may develop resinous reddish streaks and later the wood disintegrates into a soft yellow-white spongy rot. This rot may be confined to a single lateral root or may advance into the crown and up into the lower bole. If confined to a lateral the tree may struggle on for years but once the rot goes into the root collar the tree is girdled and killed.

Drought seems to be one of the most important factors leading to infection by Trametes radiciperda. The rot is also rather prolific in areas following insect attacks, sustained sulfur dioxide injury, and where the soil is shallow and wet. Where trees are not affected by these factors neither Trametes nor Armillaria seem to be much of a problem. Even when under the same adverse conditions it is apparent that natural stands are not nearly susceptible as are the planted stands. Regardless of the care taken trees are injured by planting and of course this applies particularly to the roots.

Serious outbreaks of T. radiciperda are occurring in Europe and North America following thinning of plantations. The infection generally seems to be heavy in heavily thinned and rather light in medium to lightly thinned stands. There are relatively few losses in unthinned plantings and in natural stands of white pine or Douglas-fir. The fungus obviously builds up and spreads as the number of fresh-cut stumps increases. The increase becomes extremely serious when an attempt is made to grow a second or third crop of conifers on the same land. This will be a big problem for foresters who wish to raise successive crops.

There are but a few practices available for control of this disease. The best is proper site selection. In the plantation pulling or digging out stumps and roots reduces the chances of infection through contact with infected material. In thinning operations care should be taken to prevent injury to residual trees. The need for thinning can be reduced by wider spacing of the original planting. When thinning is necessary fresh stumps can be painted with

a protective material such as creosote or urea. Creosote is poisonous to fungus spores while urea promotes the growth and development of secondary organisms which prevent establishment of Trametes. Either material must be applied immediately after the tree is cut. Since the use of both materials is still in the test stage it is now known how effective they will be in the long run.

Part V - Plant Protection Organization

Your country is making an effort toward increasing the amount of wood produced. Much of the planned increase is to come about through new plantations and through intensified treatment of these plantations. It is rather common knowledge that the application of the methods of mass production to crops results in a need for intensified protection from insects and diseases. Since the growing of trees is a national effort the protection of them must also be a national effort. Much of the planning, financing and leadership must be done at the national level if you are to have a well-coordinated program of forestry and forest protection. The two are inseparable. Without forestry there is obviously no need for forest protection. Without forest protection intensified forestry will be a failure.

In any forest protection organization you must have a staff of well-trained men - men trained beyond the forestry level. Men who can assume responsibility for detection and control of forest pests. Beyond the national leadership and the well-trained protection men in the field you need the alertness and cooperation of all foresters and forest guards. Obviously the foresters and protection men who formulate the plan of protection will know about it. But the protection men and foresters in the field must know the long range plan also so they can direct every effort toward fulfillment of the plan and not actually be going against it by their lack of knowledge. This means there should be a rapid and continuous exchange of information from the various headquarters to the field on matters of policy and program, and from the field to the central positions on the disease and insect outbreaks and the effect of various control treatments against them.

Plans for protection must be built into the forestry plans and the budget funds must be set up to provide for protection emergencies. Either through the forestry or plant protection offices quarantines are usually drawn up to regulate importation of diseases from foreign countries and their movement between the various republics or forest districts. These same offices can be used to direct control and eradication of diseases. In the movement of tree diseases such as Lophodermium and blister rust from the forest tree nurseries a very rigid system of inspection and certification should be initiated. In the United States we have in our Agriculture Department a Plant Pest Control Division which in cooperation with other agencies carries out the operations to control introduced diseases, enforce quarantines, and heads up a nation-wide pest survey, reporting and forecasting service.

An organized system for making surveys and reports is required if an effective attack on either insect or disease problems is to be made. Fundamental to control is a knowledge of where the pest occurs, and how abundant and aggressive it is. Detection then is the first step and the least expensive and most effective system of detection is to have the field people themselves trained in recognition of the problems that occur or may occur in their forests.

Infestation or infection of a few trees by a pest does not mean that serious losses must occur but it certainly is possible that they may occur. Thus discovery of an outbreak must be followed by an educated appraisal of the situation. Here the presence of a trained man is essential. The occurrence of the pest must be reviewed in light of current information on its behavior and development elsewhere or in past years and an estimate must be made of its likely effect in the present attack. The detection and particularly the appraisal methods may differ considerably with the pest, the forest type and the section of the country.

Essential to all forest pest surveys is the keeping of records. Data on the presence, and extent of the outbreaks, and on the environmental conditions affecting its development are needed for the appraisal of the present and future occurrence of the pest. It is impossible and unnecessary to examine every forest area every year for pests. Sample plots, either permanent or temporary, may be inspected periodically to ascertain the development of various forest pests. The methods of detection and appraisal are still highly flexible and new improvements in data taking, recording and analyzing are being found every year.

I have mentioned that any plant protection organization must have trained men. To me this is the most obvious weakness of the Yugoslav forestry program. Not the training of the men currently working in the supporting specialities such as forest soils, entomology, pathology, etc., but the serious lack of numbers of such men. I believe that the training of more such men in these allied fields is the greatest step that can be taken to further Yugoslav forestry. These men are presently needed in the forestry faculties to help relieve the load of men already teaching and to fill positions where there are presently none or where the work is done by visiting professors. Once these positions are strengthened Yugoslavia can train her own specialists for administrative, supervisory and field positions.

Foremost in developing methods, analyzing outbreaks and providing the bases for control should be the institutes and Service Units. They should share, along with the Forestry Faculties, the responsibility for basic and applied research and they should provide a strong core of specialists for staffing a protection organization. Within these groups should be the basis for free exchange of research ideas, and for the collection, publication and dissemination of information. The staffs of these facilities should be instrumental in the formulation and administration of pest control regulations. Their operations should be integrated at the national level and their finances and programs should be allocated so that one does not duplicate the other and so that the problems of primary interest to the nation's forests are worked upon in the order of their importance.

Remarks and Suggestions

This last portion of the main body of the report is an attempt to draw together and thus to emphasize some of the factors that may be of benefit to the national program for conifers in Yugoslavia. These statements are necessarily based on opinions and impressions and therefore are offered as suggestions rather than as definite recommendations.

1. One of the most important actions that officials in charge of Yugoslav forestry can take in connection with the afforestation and reforestation program is a more rapid adoption of many basic management and production improvements known to nurserymen in most parts of the conifer growing portions of the world. Many such improvements were detailed by Dr. Felix Czabator in his 1961 Report "A Modern Forest Nursery Program for Yugoslavia".

2. The permanent location of an industrious man well-trained in forestry and nursery practices should be a primary goal for each of the sectional forest tree nurseries.

3. The question of proper site is the most important and one of the most easily controlled factors in nursery or plantation protection. It is far more economical to make the decision not to grow trees in unfavorable sites than it is to plant and gamble on getting some kind of crop.

4. There is a great need for an increase in experimental plots and trials both in growing trees in various areas of Yugoslavia and in testing protection methods and materials against various insects and diseases.

5. The tendency in certain forest districts seems to be toward greater expanses of pure, even-age plantations of conifers - particularly eastern white pine. Without question these are the cheapest and easiest to establish and maintain, but also without question is the greater susceptibility of such plantings toward diseases and insects.

6. The use of conifer planting stock not over 4 years in total age should give good field survival and should result in less shock to the plant at the time of field planting. A greater turnover in the nursery would result and the cost of establishing plantations would be less.

7. Money and labor must be provided for care and protection of trees after they are field planted else all previous investment will be lost. Light and frequent thinnings and prunings are very desirable for both white pine and Douglas-fir.

8. It is suggested that further investment be made in the native trees of Yugoslavia. Pinus nigra, Pinus sylvestris, Larix europea, Abies pectinata and Picea excelsis are all very desirable species in parts of the country. Their productivity can be increased by breeding and selection for fast growth and resistance to disease and insect pests. These trees may prove of more value to Yugoslavia than the introduced conifers even though they do not grow as fast.

9. The planting of any large amounts of Douglas-fir should be approached with caution as the two needle casts Rhabdocline and Adelopus are present in Yugoslavia where the host is grown and have severely limited or even curtailed the use of the tree in many parts of Europe.

10. It appears that young plantations of eastern white pine may be very seriously damaged by Armillaria mellea in areas being cleared of low-grade hardwoods. Stump pulling and raking out of roots may result in less infection of pines but cannot be expected to control the disease completely.

11. The dangers and recommendations concerning white pine blister rust have been enumerated in the section "The Eastern White Pine in Yugoslavia" included in the appendix.

12. The need for a greater number of men trained in forest protection is readily apparent. This bears no reflection on the quality of the men presently concerned in this work but merely serves to indicate the immensity of the job ahead - especially if the plans for intensive forestry are carried out.

13. There also appears to be a need for increased cooperation and exchange of information between the Yugoslav people in forestry and related fields and between the Yugoslavs and peoples of other countries of the world.

REPORT

to the

GOVERNMENT OF YUGOSLAVIA AND USAID/Y

Robert W. Brandt
Forest Pathology
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October 18 through November 30, 1961

Arrived in Belgrade the night of October 18, 1961. The period from October 19 to October 26 was spent conferring with various members of: (1) the Federal Chamber of Agriculture and Forestry, (2) the Institute of Technical Assistance, and (3) the United States Aid Mission Food and Agriculture Division. During this period the first portion of my program was developed. Later, in Zagreb (November 9) I met with Ing. Bura of the Forest Extension Service and Ings. Lovric and Hajdin of the Conifer Institute at Jastrebarsko to discuss a general program for the rest of my stay in Yugoslavia.

From October 27 to November 13 in Croatia and from November 13 to November 27 in Slovenia, I made observations on the health and general welfare of American species of conifers planted in nurseries, plantations and old stands. With the exception of the Douglas fir (Pseudotsuga taxifolia) and Eastern White Pine (Pinus strobus), and possibly Port Orford cedar (Chamaecyparis Lawsoniana), the latter for use in very limited areas, I saw no American conifer species that looked to be important additions to Yugoslav forest economy.

Only one small forest stand (Brezona Reber) of C. lawsoniana was seen. The trees appeared to be perfectly healthy but for 53 years of age were of rather small diameter and were obviously either rather slow growing or stagnated. In general, the tree has a reputation for slow growth where planted in Europe. It should be noted, however, that in a small planting near Gradac (Slovenia) the trees after three years in the field were averaging close to a meter per year in height growth. They should be observed to see how long this growth rate is maintained. At best, the rather strict requirements of the species will limit its economic production.

In general, the 40-70 year old stands of Douglas fir and eastern white pine appear to be quite healthy while the younger stands of both species are subject to several diseases. It is my opinion that the older stands are healthy because: (1) they are situated on generally good sites, (2) they were planted in small, widely-separated groups, and (3) they have grown to an age and size which makes them quite resistant to the diseases now attacking the younger trees. Then, too, there is no possible way to know of the number and extent of failures that may have been incurred while producing the present old stands. Certainly the Armillaria mellea and Trametes radiciperda root rots now becoming serious on young plantings are not new diseases in Yugoslavia.

Two other general statements should be made. The first is that some Yugoslav foresters apparently look upon these two species as the answer to all timber production problems. The idea that either Doubias fir or eastern white pine, or the use of both, will unfailingly produce high yields and permit reforestation and afforestation of poor forest lands is erroneous. Secondly, the practice of mono-culture in species that do not naturally grow in pure culture, has been proven time

and again throughout the world, to lead only to large failures and great economic losses. Yugoslavia is closely surrounded by many examples involving the same two species.

DOUGLAS-FIR

The only variety of the Douglas-fir (Pseudotsuga taxifolia) successfully grown in Yugoslavia is the Pacific coast or green Douglas-fir (P. taxifolia var. viridis). This tree has been seen to double or triple the volume increment of the native species, Picia excelsa or Abies pectinata. In some places it is beginning to reproduce naturally.

Even within the variety "viridis" the various stands are characterized by great differences in bark appearance, natural pruning and size of limbs. How much of these differences are due to history of the individual stands and how much to seed origin is difficult to say. There is a general lack of knowledge as to the origin of seed and year of planting.

There are currently three serious diseases present in northwestern Yugoslavia, any one of which may prevent the wholesale production of Douglas-fir. Rhabdocline pseudotsugal and Adelopus (Phaeocryptopus) gaumanni are fungi which attack young foliage of Douglas-fir and may either kill the tree or weaken it to the point where other fungi or insects may attack. The Adelopus appears to be the most widespread and serious at present and has been observed in plantations from Istria to north-eastern Croatia. A canker producing fungus, Phomopsis pseudotsugae, is also present in Yugoslavia, killing young trees by its girdling action and seriously deforming older trees.

In addition to these diseases an insect, the aphid Adelges cooleyi occurs commonly on the Yugoslav Douglas-fir. It is believed to be causing little damage although at times it builds up heavily on individual trees.

Croatia

Douglas-fir seventy years old were seen in the forest near Skrad, Croatia. These trees were the largest D. fir seen in Yugoslavia (some 76-78 cm. diameter breast high). They were generally thick barked and pruned quite well. The latter may be because they were among a rather dense stand of Abies pectinata. The origin of the D. fir was unknown. Cones have been produced for a number of years but the seeds produced are empty for some undetermined reason. The crowns were too high to determine the presence of foliage diseases. Two partially suppressed trees had stem cankers which might possibly be caused by Phomopsis.

A stand of about 50 Douglas-fir was examined at Klana, near Rijeka. The trees were 45 years old and had reached a height of about 35 meters. The largest diameter observed was 42 cm. at breast height. Top growth of some trees was still about a meter per year. A few naturally reproduced trees of 2-5 meters in height were scattered through the nearby beech forest. No diseases were observed.

The Douglas-fir in Hiterot Park in Rovinj have become stagnated at about 50 years of age. Tops are flat and many are browning and showing signs of deterioration. It is possible that such damage may be from salt since these trees are but a few meters from the Adriatic. In addition to top decadence many stems show long cancerous lesions of undetermined origin but the presence of Phomopsis pseudotsugae is highly suspect.

The cankers were too high to examine in detail and no trees are allowed to be cut in the park. Nearby reproduction from the Douglas-fir was unusually prolific and should be thinned if only for aesthetic purposes. A number of these trees have been dug and transplanted to other park areas. Here among the transplanted trees a heavy outbreak of Adelopus is present. A few trees are already nearly devoid of foliage and it appears that many of these trees will be lost. The thick residual reproduction is also moderately infected with the same disease. The severity could undoubtedly be lessened by proper thinning and pruning to a third of the height of the tree.

At Vinica, near Varazdin, a 50-year old stand of Douglas-fir is already nearly 50 meters tall. The area is a little over 2 hectares in size and the trees are reproducing naturally. Some of the seedlings have been transplanted to other nearby areas. In a mixed planting of Douglas-fir, Pinus strobus and Picea excelsa, the Douglas-fir is moderately infected with Adelopus and there appears to be much Adelges cooleyi.

Slovenia

In Slovenia, at Pecovnik, a small amount of Adelopus was found on reproduction beneath the 50-60 year old Douglas-fir. The older trees appeared healthy although no close examination could be made of the foliage.

On the Douglas-fir in the vicinity of the Rupe Nursery, Tomaj (near the Italian border) both Adelopus and Rhabdocline were found. These trees were in a state of bare existence and it is doubtful if properly timed release could have saved them. The Adelopus is far more serious than the Rhabdocline.

At Planina, several areas were planted to Douglas-fir beginning about 1920. Some of these trees were scattered through the forest and others planted in groups. Many of the scattered trees soon outgrew their neighbors and thus became wolf trees with large limbs and heavy crowns. In the younger trees (scattered to the extent of 10% of the total number of trees), both Adelopus and Rhabdocline are present. From the thin, unhealthy appearance of these trees there is no danger of them overstopping others. The foresters report that in 1956 over 1500 trees were cut and burned because of heavy Rhabdocline infections. A group planting, a little over 3 hectares in size, has seventy-year old Douglas-fir with approximately 460 cu. m./hectare. The present plan is to plant Douglas-fir in scattered groups with one or perhaps two hectares being the maximum group size.

EASTERN WHITE PINE

The eastern white pine (Pinus strobus) consistently grows faster than Yugoslavia's native conifers and has been seen over a wide range and on extremely different sites. Most stands tend toward heaviness of limbs and poor self-pruning. A good program of silvicultural management will be an early requirement of the future stands for best return on the investments made. In general the white pine does not appear to have grown as fast as the Doublas-fir but is is so much more adaptable than the fir that it will undoubtedly be the mainstay of the conifer introduction program.

The white pine blister rust fungus Cronartium ribicola is present in Yugoslavia and unless proper early measures against it are taken it may become the limiting factor for pine here as it has in most of Europe. In addition to this

serious threat, the root rot fungi Armillaria mellea and Trametes radiciperda are common and already damaging many young W. pine plantings. The pine bark aphid Pineus strobi is building up to great levels on older trees and at least one instance was seen where this insect was doing serious damage to young natural W. pine reproduction. This was immediately adjacent to a 100-hectare clearing, much of which is being planted to white pine.

Croatia

Eastern white pine, 70 years old, has made good height and diameter growth at Donja Stubica north of Zagreb. These trees were slightly yellowed in color and the shortened internodes in the uppermost crowns suggest that all trees had reach their maximum age for the site. Most trees had pruned poorly and some were forked probably from snow damage. A second stand of 40 year old white pine appeared to be in good health. No blister rust has ever been found in this area of Croatia. It is intended that the low grade oak will be removed and fast growing conifers, especially white pine be substituted.

A few 60-year old W. pine near Samobor were of good diameter (26-27 cm.) and form but the branches had been cut off some 8-10" from their base so that more light could reach the adjacent spruce nursery. Flush pruning would have given the same result and resulted in greatly increased tree value. No diseases were seen and it was said there were no Ribes (alternate host for Cronartium) in the area.

At Duga Resa, visited the white pine on the private forest near the village Bosiljevo. The trees were 60-70 years old and there was considerable natural reproduction. Much of this needed to be released from overtopping hardwoods. No diseases were seen.

About 275 white pine of 70-80 years were observed in part at Donja Dobra near Skrad. One of the larger trees was 65 cm. diameter and roughly 45 meters high. Some natural reproduction was present but no diseases were seen.

Pinus strobus, 30-40 years of age were scattered among beech coppice and in mixture with Norway spruce at Klana. The north slope had favored the spruce and this had largely overgrown the w. pine. The latter was healthy appearing but was not of good size. In the park (Brdo) near Klana many stems of the 50-60 year old white pine were crooked and several were forked, both conditions resulting from the strong northeast winds from the continent. In addition the trees were very rough-barked and heavy limbed and did not appear to be a good strain for future seed collection.

At Zelendvor near Vinica, white pine has been planted in small groups among the hardwood forest. Many trees have been deformed by deer either by browsing or by rubbing with antlers. A small amount of white pine bark aphid was seen on young trees while two separate severe outbreaks were found on the original 51 year old stand. No disease was observed on the white pine. Agricultural-forestry techniques are being developed for conifers in this area similar to those being used for poplar in Italy and here in Yugoslavia. White pine has been interplanted with such crops as corn, oats and legumes. In some cases the trees have been 2-3 meters in height when transplanted with but 4% loss. A wide spacing of 2 or 3x4 meters is used to facilitate agriculture. It is expected by many Yugoslav foresters (but completely without benefit of research trials)

that fertilizers, cultivation, etc., of both agricultural and forestry crops will be paid for by the increased growth of the trees.

At the nursery Marushevec 2-0, 2-1 and 2-2 white pine were examined. Trees commonly reach a height of about a meter after four years and are then planted out to areas cleared of low grade hardwoods. Many areas of the seedling beds appeared to suffer from excess water and nutritional disturbances.

Slovenia

The plantations of 53 year old white pine on the Brezova reber did not appear to be a great success although giving better growth than the local species. A rather extensive program was underway to plant up abandoned farms with mixtures of white pine, Norway spruce, Douglas-fir and European larch. Tractors equipped with power augers were used to dig holes, fertilizer added, and 2-year old trees planted. After 2 years in the field the trees will be fertilized a second time. Some frost damage was evident on the spruce and on an occasional white pine but in general the planting was too young to determine its success.

Near Gradac a field of w. pine transplants appeared to be in good health. These trees go to the field as 2-2 stock. Eventually the area will be part of a white pine plantation. The nearby nursery wherein the seedlings had been grown was located on rather heavy soil and was subjected to periodic flooding, neither condition being very conducive to producing the best seedlings.

Also in the Gradac area a 100-hectare clearing for agriculture and plantations was nearing completion. The previous cover had been poor quality oak and birch. The presence of large amounts of hardwood root material in the soil would seem to make root rot infection from either Armillaria or Trametes very likely. Since the planting was only beginning at the time of observation it was impossible to adequately gauge the importance of these fungi. Pathologists later described 10-12 year old white pine plantings north of this area which have been heavily damaged by these root rot fungi - particularly by Armillaria. An attempt will be made to see these areas at a later date.

Plantations of Pinus strobus in the Celje-Maribor areas were few in number, small in size and rather disappointing in the quality of trees produced. In the park at Viltus Castle 50 year old white pine had been harvested in the spring of 1961. The decay from Trametes radiciperda was found to extend 1-2 meters up the butt log. Remaining trees were extremely heavy limbed and showed general lack of care. They appeared to have stagnated and examination of stumps revealed this had occurred after 20-25 years.

On Rdeci Breg white pine occasionally reached a diameter of 50 cm. in 40 years but suffered somewhat from snow damage. Severe snow damage was observed on the pine near Areh. The pine seems to have no particular advantage over the native species in the hills of the Pohorje range.

In the swampy areas southeast of Slov. Bistrica the eastern white pine has made good growth and appears to be healthy. Since the Norway spruce

in the same area has repeatedly suffered from frost, insects and high water table the plans are to ditch the swamp and plant white pine among hardwoods (oak, black alder). It would be advisable to conduct but a limited test on such areas since Polyporus schweinitzer and Armillaria mellea operate readily under such conditions.

Pinus strobus planted by the villagers of Pivka 35 years ago had reached approximately 20" in diameter but had suffered heavily from snow and ice breakage. The trees had received no care and were double topped and heavy limbed. The elevation was about 650 meters but the area is located in the path of the bora winds from the continent. The soil was derived from sandstone and lies surrounded by Karst. Near Oscjnica white pine were actually growing on the limestone but in areas where the carbonates had been leached out.

At Mala Bukovica near Ilirska Bistrica some 300 hectares of scattered white pine have reproduced to the extent that much of the pine is nearly in pure stands. The private owners have intensified this condition by removing the intermixed hardwoods to favor pine. Originally only 15 hectares had been pure pine. It is apparent that the insect Pineus strobi and the root rot fungi Armillaria mellea and Trametes radiciperda are becoming serious factors in the future of the stands. Local foresters report pulling and burning many young trees killed by the fungi and many more were seen during the current trip. It is recommended that hardwoods be left among the pine to moderate disease outbreaks even though they fail to add to the productiveness of the stand.

REPORT

to the

GOVERNMENT OF YUGOSLAVIA AND USAID/Y

Robert W. Brandt
Forest Pathology
PIO/T 158-17-090-3-10125

December 1961

The month began with a December 1st conference at the Federal Chamber of Agriculture and Forestry with Ing. Dimitrije Bura on the white pine blister rust problem. Dr. L.H. MacDaniels of Cornell University, here in Yugoslavia on a small fruit assignment, presented the horticultural aspects of the problem. We were asked to draw up a joint account of the disease and its importance to Yugoslavia. This was done (Dec. 4-5) and the paper presented to Mr. Bura on December 6.

On December 7, Dr. MacDaniels and I visited the Forestry Faculty in Belgrade with Mr. Jeftic of the Forestry Chamber and Mr. Stilinovic of the Forestry Faculty (the latter serving as interpreter). Met Professor Dr. Krstic and his assistant, Dr. Malenkovic, and discussed forest pathology problems in Yugoslavia.

Visited the park at Avala but freezing rain prevented anything but superficial inspection of the conifers present. Continued to the Ripanj nursery where all trees were being balled and burlapped for park planting. White pine looked very good except for some that had been transplanted during last fall's drought. These trees ranged from 2 to 5 years in age. At Tresnja the pine and other conifers were being planted in a partially cleared area by women and girls. The residual oak overstory was quite old but of very small size and poor form. There was much oak stump and root material throughout the planting area and this should serve as ideal substrata for Armillaria mellea although none was noted in a quick check of a few trees.

In another area of the park at Tresnja, Douglas-fir planted in 1956 as 2-0 stock was making good growth. The trees were heavily covered with sooty mold presumedly following attacks of Adelges Cooleyi. No other fungus diseases were noted. An adjacent planting of Abies concolor was severely damaged by what appeared to be the same mold. Many of these trees were stunted, yellowed, and obviously near death.

On December 8, Ing. Stilinovic and I started for Kraljevo to observe American conifers in that area. Heavy snow and a resultant traffic jam on the highway forced us to return to Belgrade.

December 9-11 was spent in Belgrade working on reports and reviewing literature for the Yugoslav project.

Arrived in Skopje, Macedonia, the morning of Dec. 12. Had conferences with Ing. Vojislav Stojanovski, Secretary of Forest Service in the Chamber and Ing. Boris Grujoski, Chief, Forest Service, P.R. Macedonia. With Mr. Stojanovski visited the Forest Institute and Forestry Faculty, both in Skopje.

A few ornamental trees of Douglas-fir and eastern white pine were seen behind the building at the Forest Faculty on Dec. 13. Neither species was doing well. The D.fir

was infected with Adelopus and the white pine was heavily covered with the wooly aphid, Pineus strobi. Visited the nearby arboretum, where less than half a dozen trees of each species were planted. No fungus diseases were seen but the trees were not healthy because of the extremely high water table. Only the American conifers Juniperus virginiana and Thuja plicata looked good. Chamaecyparis lawsoniana appeared very unhealthy.

December 13 through December 17 was spent in a tour of western Macedonia. With Ings. Simjanoski and Stojanoski visited the Perister National Park to see Pinus peuce. Reciprocal grafts between P. peuce and P. strobus were seen at the small nursery in the park.

At the nursery in Bitola 9 year old eastern white pine and Douglas-fir were seen. Stems of the pine were matted with wooly aphid and numerous lesions on many limbs appeared to be from hailstones. The D. fir appeared healthy. Both species had had very preferential care in the nursery, including fertilization and watering.

With Ings. Stojanoski and Poposki (the latter is Chief of the Center for the Amelioration of Degraded Forests) I visited the demonstration and project areas near Kazani. Most of the troubles in the nursery were believed to arise from the high pH (6-6.5) and the lack of organic matter in the heavy soil. The first clearing and planting projects in the degraded forests were observed. These had just been initiated and no conclusions could be drawn except that it looked very expensive.

The horticultural nursery at Ohrid has produced eastern white pine for the Kazani project. Most of the material grown there has been used for recreational and municipal plantings however.

On returning to Belgrade the period Dec. 18 to 30 was spent in assemblying and reviewing materials for use in future seminars and project reports.

A tentative outline for the seminar was turned in to Ing. Bura December 27.

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January 1962

The month of January was spent in Belgrade. Several short conferences were held with Ing. Bura at the Forestry Chamber and two visits were made to the Forestry Faculty, Belgrade.

On January 17 discussed southeastern Europe's forest disease problems with Dr. M. Krstic, Yugoslavia's foremost forest pathologist. The quarantine on Lophodermium was discussed and it was agreed that it is a very worthwhile program. The spray control programs in the forest nurseries would be more effective if closer attention were paid to timing the first spray and to keeping the foliage covered with a film of spray throughout the sporulation period.

The program of the Coniferous Institute at Jastrebarsko was reviewed and the relationship of fast-growing introduced vs. fast-growing native conifers discussed. The reciprocal crossing of Pinus peuce with Pinus strobus seems to be a wise step in the search for 5-needle pine resistance to the blister rust fungus. Some outstanding points of interest in the subjects of oak dieback and poplar breeding were brought out during the course of the meeting but since they have no bearing on the conifer program they are not reported here.

Most of the month was spent in writing up a presentation for a Forest Protection Symposium to be held in mid-February and in collecting and preparing lecure and illustrative material for forest pathology.

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Robert W. Brandt
Forest Pathology
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February 1-16, 1962

On February 1st I gave an illustrated lecture on the introduced American conifers in Yugoslavia, their disease problems and protection from diseases. This lecture was presented to members of the Agriculture and Forestry Chamber, the Forestry Faculty of Belgrade and to members of various forestry and protection institutes. A total of 38 attended, but this was considered to be a good crowd considering the heavy snowstorm in progress.

The period from February 2 to February 10 was spent in Belgrade working on final report, revising the lecture and shaping up the symposium presentation.

On Sunday, February 11, traveled to Zagreb. After failing to contact Ing. Hajdin at Jastrebarsko on Monday morning (February 12) checked in at Forestry Secretariat. Presented early evening lecture (approximately same lecture as February 1) to forestry and protection people at the Forestry Society meeting rooms. It was estimated that 50-55 people attended.

February 13th was spent traveling from Zagreb in Croatia to Novo Mesto, Slovenia and later to Dolenske Toplica where the symposium was to be held.

February 14. Participated in the first part of the symposium for the protection of conifers in Yugoslavia. Ing. Stilinovic served as a very able interpreter. Mrs. Petrovic distributed disease exhibits to the audience. Both are from the Forestry Faculty at Belgrade. Nearly an hour was taken for questions and discussion. After a recess Dr. Zivojinovic gave a discussion on conifer insects, followed by the first showing of a color film on poplar cultivation in Yugoslavia. This film was made under the direction of Ing. Bura, Extension Forester. I had to leave the group shortly after dinner to catch the train in Zagreb for Belgrade. Arrived in Belgrade the morning of February 15 to complete the final few arrangements for my departure to the United States.

EASTERN WHITE PINE IN YUGOSLAVIA

R. W. Brandt
Forest Pathologist

January 2,1962

At the request of Ing. D. Bura of the Forest Extension Service, this report has been written to present my opinion of the eastern white pine (Pinus strobus) and the white pine blister rust problem in Yugoslavia.

Any coniferous tree that can grow at a rate 2 or 3 times that of the local conifers demands attention from those charged with developing wood materials for the Yugoslav markets. The Douglas-fir and eastern white pine have consistently grown at such rates in the past and it is expected that they might continue to do so in the future. Two possible deterrants to these expectations are the use of poor sites and tree diseases. Both may become increasingly important in the near future. This report will be restricted to remarks on the eastern white pine.

The white pine in Yugoslavia at present is largely from 40 to 80 years old. The plantings are small in size, very widely scattered and are largely park-like portions of former estates. By and large they are planted on fairly deep soils on well-drained slopes. The majority of plantings are in northwestern Yugoslavia. In almost all cases the stands have stagnated after 50 to 65 years. Individual trees appear quite healthy particularly in regard to fungus diseases. Some older trees are known to be infected with decay, notably that caused by Trametes radiciperda.

In young white pine stands the root rot fungus Armillaria mellea is rapidly becoming a serious problem. This is particularly so in areas cleared from scrub hardwoods and immediately planted to pine but it is also true where intermixed hardwoods are being cut to release and favor pine reproduction.

Perhaps the greatest single threat to white pine production in Yugoslavia comes fron Cronartium ribicola, the white pine blister rust fungus. The fungus disfigures,

stunts, and occasionally kills large trees but it is particularly effective in killing young trees whether they are natural seedlings or planted stock. It is well known that this fungus has been the limiting factor in white pine production in many places in Europe. Where there are no or few susceptible currant or gooseberry bushes (the genus Ribes is the alternate host and without spending part of its life on these plants the fungus cannot survive) the white pine has been grown successfully for 3 or 4 generations in certain European forests.

Several species of susceptible currants grow naturally in northwestern Yugoslavia. Any strong program for planting white pine in this region should make provision for the eradication of these susceptible Ribes particularly near forest tree nurseries where white pine is to be grown. Since it takes three years or more for infected trees to show symptoms of the disease and since even year-old seedlings are easily infected, the disease could be widely scattered through distribution of infected nursery stock.

The European black currant, Ribes nigra, is the most susceptible of all Ribes to the disease and it is to be regretted that Yugoslavia feels it necessary to introduce this plant concomitantly with the eastern white pine in the attempt to bolster her economy. Since the Union of Agriculture and Forestry Chambers seems to be firmly committed to both programs it is recommended that authority be delegated to someone to take the responsibility of correlating the two programs so that serious losses to white pine already planted or scheduled for planting will not occur.

In the northwestern area where wild susceptible Ribes occur the decision should be made whether to initiate an eradication program or not. Such a program will be extremely costly and physically very difficult due to the rugged nature of the terrain. The most effective and inexpensive eradication methods for Yugoslavia must be worked out and men hired, trained and properly authorized to carry out the program. If such a program is not to be undertaken then the planting of white pine in these areas should cease and the seedlings, money and effort diverted to more promising regions. If white pine is not to be grown there is no reason that Ribes nigra plantings should not be established.

With the possible exception of developing rust resistant strains of Ribes there is no way of keeping plantations free from Cronartium infection since the currant-infecting spores

are capable of traveling hundreds of kilometers and may easily be blown here from outside Yugoslavia. In contrast, the pine may usually be protected by establishing a Ribes-free barrier of two kilometers in width around the planted area. (As a margin of safety this distance is increased to three kilometers about pine-producing nurseries.)

It has been suggested that eastern white pine can be kept free from blister rust by maintaining the trees in good vigor, by timely pruning and thinning, and by growing them in small, scattered plantings intermixed with hardwoods. While this is in part true, it is still necessary to remove Ribes from within and about the pine growing areas. In Yugoslavia too it is obvious that most of the older trees have not been pruned and that the greatest tendency is to make large scale plantings of nearly pure stands. This latter is true where many originally somewhat scattered plantings are now being joined by intermediate plantings and where the hardwoods in pine-hardwood mixtures are rapidly being removed to favor the pines and increased pine production. One is forced to question the vigor of many plantations since the presence of Armillaria mellea, long an indicator of off-site conditions and poor vigor, seems to negate the presence of long internodes (an expression of good vigor).

The profitable growing of eastern white pine in Yugoslavia is largely an unknown factor except in the republics of Slovenia and Croatia. It is true that there are a few scattered small plantings outside the northwest but not enough to give a good picture of the potential in any one place. From Serbia southward to Macedonia there is a great need for further test plantings to establish areas for intensified pine production. Lack of sufficient seed, seedlings, money and trained manpower will prevent the wholesale afforestation and reforestation that would be desirable if these items were in plentiful supply. Therefore it seems wise to use the first productive efforts to establish the future direction of work. The need for such plantings and the need to learn from them is best demonstrated by an example such as the Bela Krajina in Slovenia where wholesale planting of white pine continues adjacent to areas where the same species is being very seriously damaged by root rots.

One other impression gained in viewing the white pine program is that the issuing of credits to encourage the planting of eastern white pine is indeed doing just that. However, is appears that many districts are developing white pine projects simply to get the credits and are ignoring site

requirements, indications of insect and disease problems, etc., in order to obtain a further share of money. The ill effects are multiplied since the forester is encouraged to turn his back on many valuable stands of native species because he cannot get labor and funds except for "special projects".

Lastly, in spite of the heavy overtones of the previous pages, I want to state that I firmly believe the eastern white pine will be a successful and very valuable introduction to many areas in Yugoslavia. This will be particularly so if the advantages of good site, proper care and freedom from diseases can be given each plantation. Some specific suggestions for assuring these advantages are as follows:

(1) Decide immediately the future of the areas in which native Ribes occur and take appropriate steps, depending on the decision, either to initiate an eradication program or to open the area for commercially-grown Ribes and stop the further planting of white pine.

(2) Designate immediately, before the spring planting season, all areas in which R.nigra is to be grown commercially and insure that no further white pine is planted in their vicinity.

(3) Plan for a program of periodic thinning and pruning of white pine. It is assumed this will be done in intensively managed agricultural-forestry areas. Of chief concern then will be the areas where heavy natural reproduction occurs.

(4) Stop the concentrated planting of eastern white pine in large blocks, particularly in areas immediately cleared of scrub hardwoods. White pine does not normally grow in pure plantations and to insist on this practice will only lead to future buildups of insects and diseases.

(5) Give more attention to planting site. White pine does have an amazing ability to grow on a wide spectrum of soils but to think that it will succeed in areas incapable of supporting any other tree is not being realistic.

(6) Make test plantings in many more areas of Serbia and Macedonia before undertaking any large program of white pine introduction to these republics.

(7) Give up the practice of using such large planting stock from the nursery. This is extremely costly and highly wasteful of manpower and of productive nursery space. Moreover such trees, especially when rapidly forced with fertilizer and heavy watering, are highly susceptible to disease and insect outbreaks.

(8) Cease the production of white pine in the nurseries which are subject to heavy and regular flooding especially those with extremely heavy soils. Even when seedlings survive the sojourn in the nursery the shock suffered when moved to the drier transplant area or to the field may be in part responsible for the heavy Armillaria infection in young plantations.

(9) Be reasonably cautious in the development of large areas of intensive agricultural-forestry. Those who cite the success of the Italians in the use of conifers in this way are basing their case on ten years' work and the use of good agricultural land. At least a complete rotation is necessary to establish the value of such a venture and even then the success of future generations of white pine on the same area is highly dubious. In addition, Yugoslavia seems to be basing many of her expected high yields from agricultural-forestry on lands that have already been abandoned because they are worn out and unprofitable for agriculture alone. Neither would it be economically sound to infringe on good agricultural land for pine production while still importing food crops.

ITINERARY

Oct. 19-20	Belgrade - USAID
Oct. 21	Conferences - Forestry Chamber
Oct. 23	Conferences - Institute for Technical Assistance
Oct. 24-26	Belgrade
Oct. 27	Zagreb - Conferences - Conifer Institute
Oct. 28	Conferences - Forestry Faculty
Oct. 30	Donja Stubica - White Pine Plantations
Oct. 31	Duga Resa - Skrad - Zalensina - Rijeka
Nov. 1	Rijeka Nursery - Kiana - Douglas-Fir - White Pine
Nov. 2	Rovinj - Park Hiterot - D. fir Plantation
Nov. 4	Plitu Jezena - Zagreb
Nov. 7-8	Varazdin - Zelenduon - Opeka Park
Nov. 9	Zagreb. Conferences
Nov. 10	Planning - Lovric on U.S. Trip
Nov. 11	Planning - Disease Research Program for Conifer Institute
Nov. 13	Travel to Ljubljana. Conferences with Forestry Chamber
Nov. 14	Novo Mesto - Poljane - Crmosnjice Brezova reber - Kocevski Roj
Nov. 15	Gradac Nursery
Nov. 16	Bistra - Abies degeneration
Nov. 17	Menges Nursery - Volcji Potok
Nov. 18	Ljubljana - Forest Protection Faculty
Nov. 20	Celje - Pecovnik Plantations
Nov. 21	Maribor - Rdeci Brej
Nov. 22	Pohorjie near Arek. Plantations Cigonca Swamp at Slov Bistrica
Nov. 23	Pivka - Osojnica - Plantations Elirska Bistrica - Mala Bukovica
Nov. 24	Koper. Slavnik Mt. Plantations - Rupe Nursery near Tomaj
Nov. 25	Postojna and Planina. D.fir Plantations
Nov. 27	Ljubljana. Institute of Forestry and Woods Management Travel to Belgrade
Nov. 28-30	Belgrade. USAID Offices
Dec. 1	White Pine Blister Rust Conference
Dec. 4-6	Report on Blister Rust for Chamber
Dec. 7	Belgrade Forestry Faculty. Park Avala. Ripanj Nursery, Park Tresnja
Dec. 8	Trip to Kraljevo (cancelled in part)
Dec. 9-10	Belgrade
Dec. 11	Skopje, Macedonia
Dec. 12	Conferences - Forestry Chamber, Institute, Faculty
Dec. 13	Forest Faculty - Forest Arboretum
Dec. 14-17	Perister National Park, Bitola - Casani - Ohrid - Skopje
Dec. 18	Return to Belgrade
Dec. 19-31	Belgrade
Jan 2-31	Library - Reports - Symposium preparation
Feb. 1	Lecture - Forestry Chamber, Belgrade
Feb. 5-10	Belgrade
Feb. 11	Travel to Zagreb - Introduced American Conifers
Feb. 13	Travel to Novo Mesto - Dolenska Toplica
Feb. 14	Symposium on Forest Protection and Introduced American Conifers Travel to Belgrade
Feb. 15	Belgrade
Feb. 16	Leave Belgrade for United States